VOLUME 49 NUMBER 5

ARCHIVES OF

OTOLARYNGOLOGY

EDITORIAL BOARD

GEORGE M. COATES, Chief Editor
1721 Pine Street, Philadelphia 3

WESTLEY M. HUNT, New York
RALPH A. FENTON, Portland, Ore.
ERNEST M. SEYDELL, Wichita, Kan.
CHEVALIER JACKSON, Philadelphia
ROBERT L. GOODALE, Boston
J. MACKENZIE BROWN, Los Angeles
CARL H. McCASKEY, Indianapolis

MAY 1949

PUBLISHED MONTHLY BY AMERICAN MEDICAL ASSOCIATION, 535 NORTH DEARBORN STREET, CHICAGO 10, ILLINOIS. ANNUAL SUBSCRIPTION, $10.00

Entered as Second Class Matter Jan. 14, 1925, at the Postoffice at Chicago, Under the Act of Congress of March 3, 1879

COPYRIGHT, 1949, BY THE AMERICAN MEDICAL ASSOCIATION

CONTENTS OF PREVIOUS NUMBER

APRIL 1949. NUMBER 4

Hydrodynamics and Hearing: I. The Operative Relief of Otosclerotic and Nonotosclerotic Deafness and Its Relationship to a Hydrodynamic Hypothesis of Hearing; a Suggested Explanation for (a) the Intimate Association of the Organs of Balance and the Organ of Hearing and for (b) the Function of the Incus. Otto Popper, M.B., Ch.B., F.R.C.S. (Edin.), Johannesburg, Union of South Africa.

Transtympanic Approach and Fenestration: II. The Current Technic. Otto Popper, M.B., Ch.B., F.R.C.S. (Edin.), Johannesburg, Union of South Africa.

Acoustic, Vestibular and Other Problems Concerning Otosclerosis and Its Surgical Treatment According to Popper's Method. Robert Lund, M.D.; Harald Ewertsen, M.D.; Helmer Rasmussen, M.D.; Niels Riskær, M.D., and Svend Selsø, Copenhagen, Denmark:

I. Popper's Operation for Otosclerosis. Robert Lund, M.D.

II. Acoustic Function Before and After Operations for Otosclerosis. Harald Ewertsen, M.D.

III. Vestibular Function Prior to and Following Operation for Otosclerosis. Helmer Rasmussen, M.D.

IV. Biochemical Conditions in Patients with Otosclerosis. Niels Riskær, M.D.

V. Conditions of the External Auditory Meatus and the Tympanic Membrane in Patients with Otosclerosis. Svend Selsø.

Actinomycosis Involving Ethmoid and Maxillary Sinuses: Report of a Case. Robert B. Lewy, M.D., and Ephraim L. Manning, M.D., Chicago.

Interpretation of Hearing Tests. Stacy R. Guild, Ph.D., Baltimore.

Abstracts from Current Literature.

News and Comment.

Book Reviews.

Directory of Otolaryngologic Societies.

FREE! A Folder Explaining A New Type of Hearing Aid Battery...The Result of Extensive Electronic Research

You can assure your patients . . . backed by the *guarantee* of Olin Industries, Inc. . . . that they will get *more* listening hours, *clearer* reception at *no extra cost* . . . because Olin flat cell "B" batteries are

INTERLOCKED

Only OLIN *"B" Batteries Have These Features...*

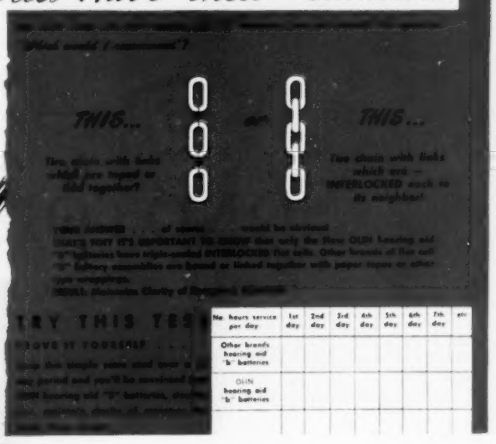
. . . YET THEY COST NO MORE

1. Only OLIN INTERLOCKED Flat Cells are Triple Sealed under fixed pressure . . . (A) Insuring against POWER LEAKAGE . . . (B) Giving each Battery dimensional stability not found in other brands . . . this feature is extremely vital.
2. Each Cell holds More Power Producing Chemicals.
3. No Waste Space.
4. 91¼ Less Soldered Connections . . . Greatly reduces Battery Failure.
5. Patented U.S. Pat. 2416576.
6. Result of War-time Electronic Research.
7. Tested and APPROVED by leading hearing-aid manufacturers.

Enlarged cutaway section shows how each cell INTERLOCKS with its neighbor

Exclusive

NO OTHER HEARING AID "B" BATTERIES have TRIPLE-SEALED *Interlocked* Flat Cells!



The coupon makes it easy to ask for your copy of this informative folder TODAY

Dept. 100
Olin Industries, Inc.
Electrical Division
New Haven 4, Connecticut

Please send me FREE a copy of your folder on Olin INTERLOCKED hearing aid "B" batteries.

DOCTOR .....

STREET & NUMBER .....

CITY ..... ZONE . . . STATE .....

"KNOW YOUR HEARING AID"

by **Irving I. Schachtel, L.L.D.**

PRESIDENT, SONOTONE CORPORATION

This booklet is the complete reprint of seven articles which recently appeared in HEARING NEWS. It was written in the sincere desire to help users and prospective users know and understand the problems involved in the need for and use of a hearing aid, so that each might achieve the greatest benefit therefrom.

If you know of someone who needs a hearing aid, and who you believe would be helped by this authentic information, we shall be glad to mail him the booklet without charge. Use the coupon below.

SONOTONE CORP.

ELMSFORD, N. Y.

SONOTONE CORP., Elmsford, New York

Please send a copy of the booklet KNOW YOUR HEARING AID to:

Name.....

Address.....Apt.....

City.....State.....

OTO.

Specific for Severe Pain

Demerol hydrochloride is a powerful synthetic for suppression of pain and control of smooth muscle spasm. Designed specifically for these ends, Demerol hydrochloride produces relatively few side effects, and combines low toxicity with great therapeutic efficiency.

Demerol hydrochloride controls pain in the great majority of surgical, medical, obstetric and gynecologic conditions.

Average adult dose: 100 mg.
Ampuls 2 cc., 100 mg.: tablets 50 mg. and 100 mg.
Vials 30 cc. (50 mg./cc.)

DEMEROL® HYDROCHLORIDE

Brand of meperidine (isonipecaine) hydrochloride

Warning: May be habit forming. Narcotic blank required.

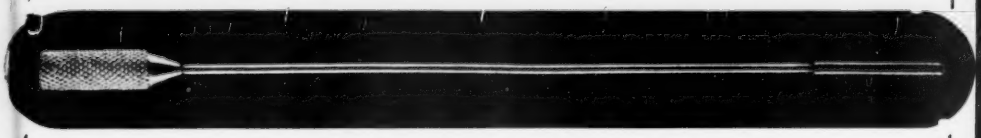
Winthrop-Stearns INC. NEW YORK 13, N. Y. WINDSOR, ONT.

RADIUM

For the Treatment of Deafness Caused by Nasopharyngeal Lymphoid Tissue

The Radium Chemical Company offered to the medical profession about four years ago, the *original* monel metal radium applicator—designed and tested clinically by outstanding otolaryngologists.

More than 1200 of these Radium Chemical Company applicators are now used by clinics and specialists in the United States. Unsolicited reports from users established the fact that results are highly gratifying.



Monel Metal Nasopharyngeal Applicator.

Published medical papers indicate that in conjunction with antibiotics, systemically or locally, there is improvement following irradiation with the monel metal applicator in patients with:

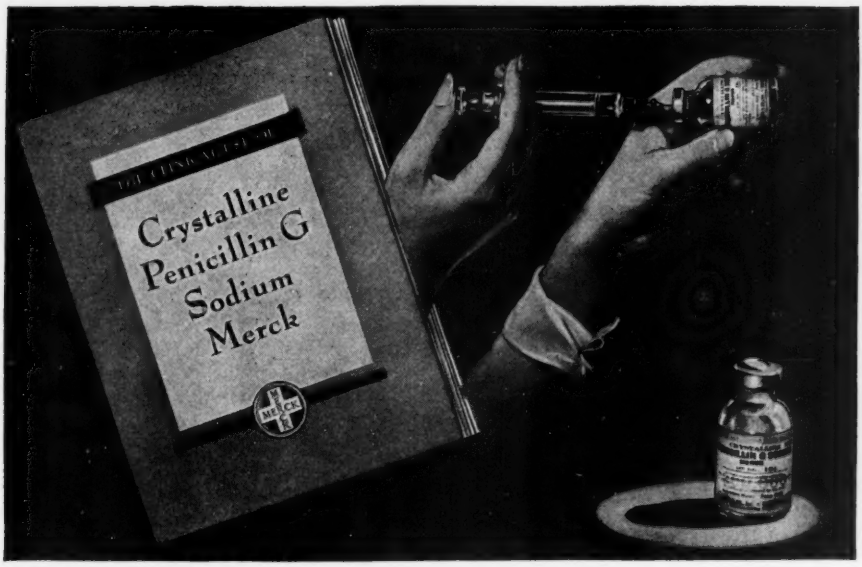
1. *Obstruction of Eustachian tubes.*
2. *Recurring attacks of acute otitis media.*
3. *Obstinate cases of chronic otitis media.*
4. *Cough secondary to nasopharyngitis.*
5. *Aerotitis in air and submarine personnel.*

Write for complete details. No obligation.

RADIUM CHEMICAL CO., INC.

570 Lexington Ave., New York 22, N. Y.

MORE THAN 30 YEARS CONTINUOUS SERVICE TO THE MEDICAL PROFESSION



This new booklet will be sent on request.

4 SIGNIFICANT REASONS WHY MANY PHYSICIANS AND HOSPITALS PREFER:

(1) PURITY—Crystalline Penicillin G Sodium Merck is unsurpassed in purity. Removal of impurities and therapeutically inert materials, and the absence of substances which may act as foreign bodies make this form of penicillin suitable for *all* routes of administration which may be indicated, including intrathecal injection.

(2) RAPID ABSORPTION AND THERAPEUTIC EFFECT—Prompt absorption of the penicillin in aqueous solution permits rapid therapeutic action. This often is an important consideration, particularly in serious and fulminating infections.

(3) SIMPLICITY OF ADMINISTRATION—Aqueous solutions of Crystalline Penicillin G Sodium Merck are easy to handle and inject. Pain and irritation on injection are reduced to a minimum.

(4) EASY ADAPTABILITY TO THERAPY—Crystalline Penicillin G Sodium Merck never is contraindicated in cases in which penicillin itself is tolerated and indicated.

● We submit these four reasons for specifying Crystalline Penicillin G Sodium Merck when penicillin is indicated.

CRYSTALLINE PENICILLIN G SODIUM MERCK

COUNCIL ACCEPTED

MERCK

MERCK & CO., Inc. *Manufacturing Chemists* RAHWAY, N. J.

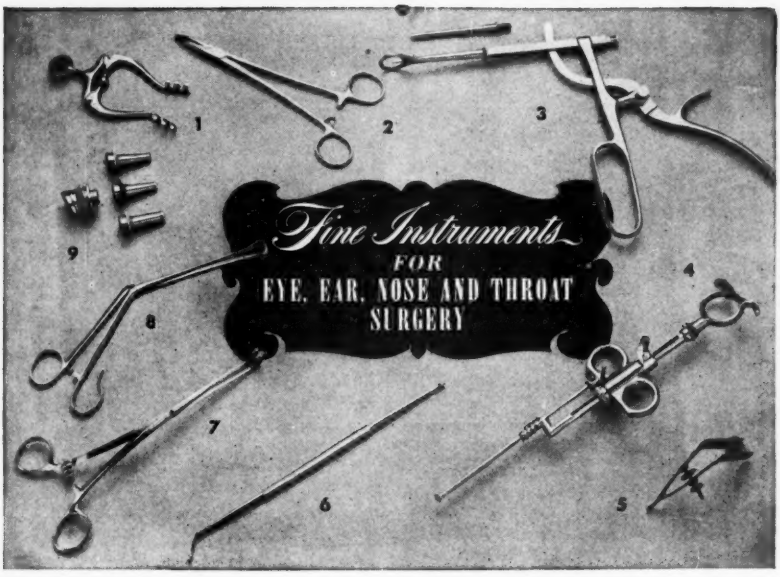
Prescribed by physicians for over 16 years...

Cosmetics for allergic and sensitive skin

Marcelle
HYPO-ALLERGENIC
COSMETICS

The Original "Hypo-Allergenic" Cosmetics
Advertised in
American Medical Association publications
for over 16 years.
Physician's formulary and samples on request.

MARCELLE COSMETICS, INC.
1741 N. WESTERN AVE., CHICAGO 47, ILL.



THE surgical instruments pictured above are representative of the great number designed by recognized authorities specializing in the surgery of Eye, Ear, Nose and Throat, and made by Pilling.

From its founding one hundred and thirty-two years ago, the house of Pilling has fully recognized the value of close cooperation between the surgeon and the instrument-maker; and it is proud of its share in the development of present-day advances in Surgery.

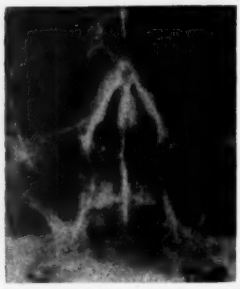
(1) *Jansen Mastoid Retractor, Rustless P1900R.*
(2) *Schnidt Tonsil Hemostat, Rustless P4632R.*
(3) *Tydings Tonsil Snare, Straight and Ring Tips P5064.*
(4) *Boettcher Tonsil Snare P5050.*
(5) *Goldstein Septal Speculum P2450.*
(6) *Spratt Double Ended Sinus Curette P2801.*
(7) *Schwartz Post Nasal Sponge Forceps P2623.*
(8) *Watson Tonsil Seizing Forceps P4668.*
(9) *Bruening Otoscope P1535.*

Write today for illustrated literature describing Pilling instruments for Eye, Ear, Nose and Throat Surgery. Address: George P. Pilling & Son Company, 3451 Walnut Street, Philadelphia 4, Pa.

INSTRUMENTS BY— Pilling

Instrument Craftsmen Since 1814

suspected . . . . .



. . . . . verified

. . . Lipiodol*

completes the diagnostic picture

From its introduction to the present, Lipiodol has remained a contrast medium of choice . . . notable for these properties: **1** 40% iodine content firmly bound in poppyseed oil, insures uniform radiopacity **2** viscosity characteristics produce clear delineation without excessive "pooling" **3** exclusive formulation does not involve use of chlorine or its derivatives **4** its blandness insures minimal irritation to mucous membranes.

100th Anniversary
E. Fougera
1849-1949
A Century of Service to Medicine

*Lipiodol (Iodized oil, U. S. P.) is the registered trade-mark for the original product created by Lafay. This product alone can bear the name Lipiodol. Made in the U. S. A. E. Fougera & Co., Inc., New York, N. Y. Canadian Distributors: Vinant, Ltd., Montreal, Canada.

ARCHIVES OF OTOLARYNGOLOGY

VOLUME 49 MAY 1949 NUMBER 5

COPYRIGHT, 1949, BY THE AMERICAN MEDICAL ASSOCIATION

FUNCTIONING OF THE AIR CELL SYSTEM OF THE MASTOID PROCESS IN AUDITION

PHILIP G. MACDONALD, M.D.
NEW YORK

THE CONDUCTION SYSTEM

PRACTICALLY all significant sounds are made by animals or objects separated from the listener by space containing air and are therefore air conducted. Most, if not all, the air-conducted sounds are conveyed to the listener through the external auditory meatus. The auricle and external canal collect sound vibrations from the air, and the middle ear modifies and transmits these vibrations to the internal ear.

The sound vibrations which have been collected and condensed in the external canal cause the tympanic membrane to vibrate, and its vibrations in turn are transmitted through the auditory ossicles to the inner ear. The eustachian tube, the tensor tympani muscle and the stapedius muscle are accessories which help to focus and aid in the transmission of sound vibrations through the middle ear. The vibrations passing through the tympanic membrane and the auditory ossicles are reduced considerably in amplitude but are correspondingly increased in force; that is, the vibrations which hit the ear drum are of relatively large excursion but weak, and the system of levers in the ossicular chain greatly lessens this excursion but correspondingly greatly increases the force of these vibrations. The decrease of amplitude and the increase of force are most essential, as the inertia of the fluid in the scala vestibuli and the scala tympani has to be overcome; also, the elasticity of the membrane over the round window must be overcome before any vibrations can be transmitted to the organ of Corti. The air is a relatively thin medium as compared with the fluid in the cochlea, and much more force must of necessity be applied to activate the cochlear fluid than to activate an equal volume of air. To counteract this, however, there is not only the favorable leverage in the ossicular chain but the difference between the area of the tympanic membrane and the area of the oval window; that is, the size of the oval window is only a small fraction of that of the tympanic membrane and must therefore receive proportionately much more powerful impulses. To summarize—the impulses at the tympanic membrane are comparatively weak but of great amplitude as compared with the vibrations of the

stapes. The sound-transmitting system of the external and the middle ear is designed to intensify the sound vibrations by decreasing the amplitude and increasing the force of the vibrations and by concentrating them at one single point, the oval window.

The tympanic membrane must be free to react to sound waves that reach it through the external auditory meatus, and these waves must be transmitted without interference through to the fluid of the scala tympani if normal hearing is to result. There are several factors which facilitate the free movement of the membrana tympani and these are:

1. The preservation of the neutral intratympanic pressure, which is achieved by the periodic opening and closing of the eustachian tube.

2. The equalization of the slight changes of intratympanic pressure caused by the action of the tensor tympani and stapedius muscles, which is accomplished by movement of the flaccid portion of the membrana tympani.

3. The neutralization of any change of the balance of the intratympanic and extratympanic pressure which might arise from the slight vibratory movement of the membrana tympani. This neutralization occurs because of the easy displacement of the flaccid Shrapnell's membrane.

4. The movement of the malleus on the hinges—the anterior and posterior malleolar ligaments—which is permitted by the flaccid portion of the drum membrane. If Shrapnell's membrane were a tight membrane, it would press on the body of the malleus and prevent its movement.

5. The absorption of pent-up sound waves. It is well known that a vibrating membrane over a closed pocket causes vibrations to build up in the pocket and that these in turn greatly interfere with the vibrating membrane. The middle ear is a closed pocket except when the eustachian tube opens intermittently. If there were no means supplied by nature to absorb these pent-up vibrations, they would build up and interfere with weak excursions of the membrana tympani, and considerable loss in hearing would result. Nature has, however, supplied a fine sound-absorbing system in the air cells of the mastoid process.

THE AIR CELLS OF THE MASTOID PROCESS

In the mastoid portion of the temporal bone the air cells are arranged in definite series of cells, and each of these series opens either into the antrum or into the middle ear directly. This serial arrangement is ideal for the disbursement and absorption of sound waves. One of the best sound-absorbing substances known is moist mucous mem-

brane,[1] and the air cells of the mastoid process are all lined with moist mucous membrane. In no case does a cell of this area normally communicate directly with the outside of the skull; the communication is indirectly achieved through the middle ear and the eustachian tube.

It has been suggested that the cells of the mastoid process might act as resonators, but they are not built like resonating bodies. It has also been suggested that the air mass of the mastoid process might act as a cushion to allow greater freedom of excursion of the tympanic membrane. This, however, is unlikely as the equalization of air is taken care of by the eustachian tube and to a lesser extent by the flaccid Shrapnell's membrane.

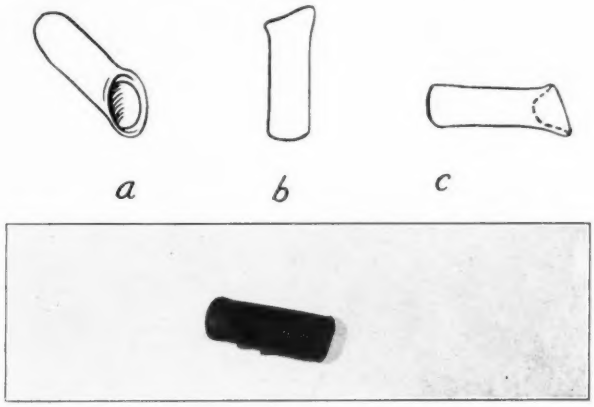


Fig. 1.—Rubber insert showing (*a*) face view of the vibrating membrane (artificial ear drum); (*b*) cross section showing one side projecting so that it will contact the auditory area around the stapes; (*c*) the concave invaginated membrane. This membrane when put in the ear is convex over the middle ear, being exactly opposite to the cone of the ear drum, which is concave in effect. The side walls are pliable and of sufficient length to hold the artificial ear drum in position.

CLINICAL OBSERVATIONS THAT INDICATE A FUNCTION OF THE AIR CELLS IN HEARING

I have been inserting artificial ear drums[2] (fig. 1) to aid the hearing of patients who have lost their ear drums. The face of the artificial ear drum is concave and slanted so that one side projects a millimeter or so beyond the other. This projecting side is inserted in the ear so that it comes in contact with the acoustic area in the region of the stapes. After one of these inserts has been applied,

1. Finch, W. S. H.: Personal communication to the author.

2. The ear drums used are modifications of the inserts introduced by Dr. Max E. Pohlman, of Los Angeles.

the hearing varies in the patient from time to time. In an endeavor to find out the cause of this variation a pertinent finding was made. When there was a crust or other debris in the aditus, the patient's hearing was definitely below expectation, but when the interfering matter was cleaned out and the insert introduced, the hearing improved considerably. Subsequent to this observation, I packed petrolatum gauze into the aditus so that no part of the pack could come in contact with the inserted artificial ear drum. I then made an audiogram of the patient's hearing (curve *B*, fig. 2). Then I removed the artificial ear drum and the gauze pack and made a second audiogram (curve *C*). I inserted the artificial ear drum (the aditus ad antrum was clear) and made a third audiogram (see curve *A*).

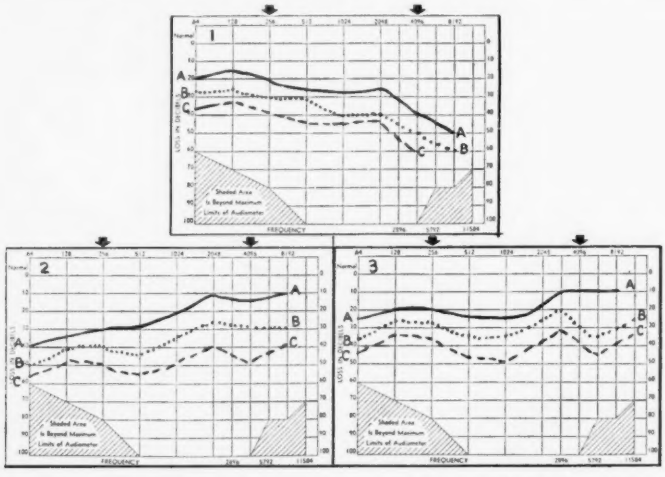


Fig. 2.—These audiograms were made on people who had lost their ear drums: *1*, patient A. S. C.; *2*, patient A. S. S.; *3*, patient S. A. D. The *A* curves represent the hearing when the aditus ad antra were clear and the described artificial ear drums were inserted correctly in the ears tested. The *B* curves represent the threshold of hearing when the aditus ad antra were obstructed with a plug of petrolatum gauze so placed that no part of it could come in contact with the correctly inserted artificial ear drums. The *C* curves represent the threshold of hearing when the aditus ad antra were clear and the artificial ear drums had been removed.

When these audiograms are examined, one sees that with the ears empty (that is without inserts) the loss of hearing is sufficient to put the hearing of these patients into the unserviceable class. When the aditus ad antra are blocked and inserts introduced and the patient's hearing tested, the audiograms indicate that the hearing does not quite come up to the serviceable level, but when their aditus ad antra are

cleared and inserts introduced the hearing becomes serviceable. In figure 2 I show the audiograms of only 3 patients, but this experiment was repeated on many patients and the results were always the same.

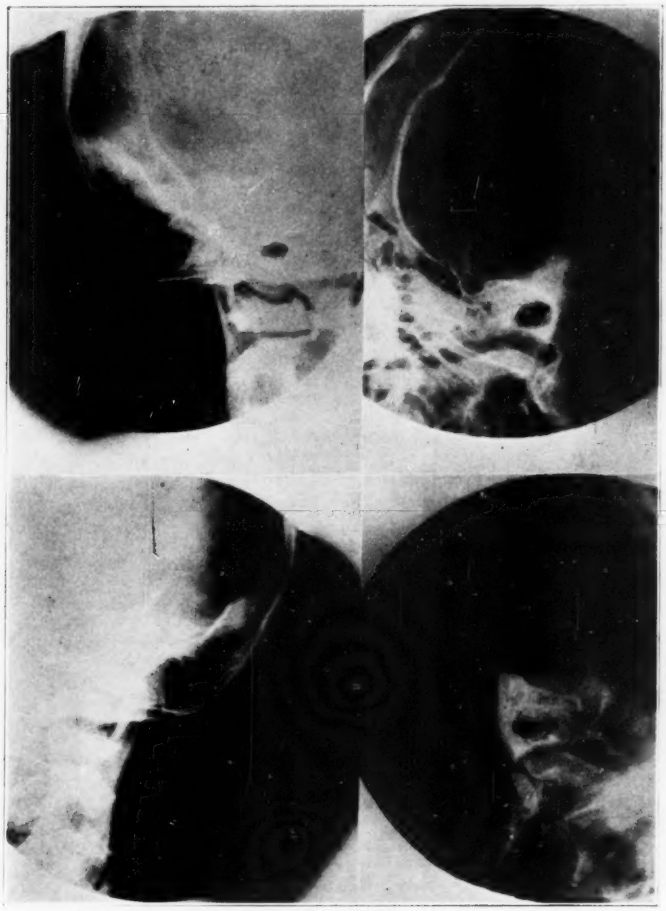


Fig. 3.—Roentgenograms of the mastoid processes of A. S. S. (above) and S. A. D. (below) taken at the time at which they were tested under the conditions described in the legend of figure 2.

I had roentgenograms made of the mastoid processes of 2 patients, and they are reproduced in figure 3. These mastoid processes are

definitely sclerotic and do not at all suggest a resonance factor as the cause of the improvement when the aditus ad antra were cleared. They do, however, suggest that the cells of the mastoid processes might act as "sound-absorbing chambers."

I took this problem to a sound engineer,[1] and he told me that as long as cells were present in the sclerotic mastoid process this would, like the normally pneumatic mastoid process, act as a sound-absorbing chamber but that the structure of neither was suitable for a sound resonator. I then decided to build an apparatus to demonstrate this fact.

EXPERIMENT

After a great many failures, an apparatus was constructed that responded to the frequencies 64 to 8192 sufficiently well to be used

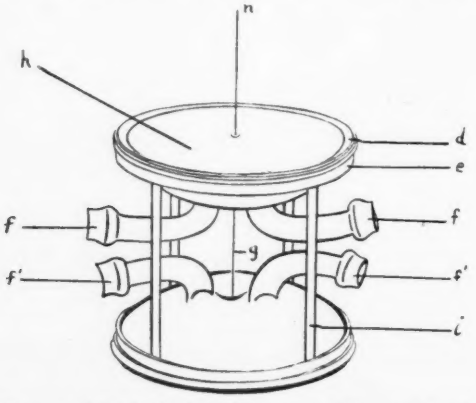


Fig. 4.—Diagram of the head of the instrument. There are two brass frames holding the diaphragms. They are held together by four supports (*i*) so that the membranes will be exactly 2 inches (5 cm.) from each other. The air space between the frames is occupied by the ducts (*f*) and (*f'*). This air space also allows for dissemination of any sound waves that might escape around the wire (*g*) (see *k* in fig. 7). This wire is 0.0025 inch (0.064 mm.) in diameter and the opening through which it passes (*k*, fig. 7) is 0.025 inch (0.6 mm.) in diameter. This difference in diameter is necessary so that the wire will not touch the sides of the opening when it is vibrating. The bodies of these frames are of cast brass and sufficiently heavy so that they do not vibrate easily. The rim (*d*) is screwed onto the shoulder (*e*) holding the diaphragm (*h*) in position. The fine wire (*g*) is glued exactly to the center of the diaphragms with airplane cement (*n*).

experimentally to determine whether the cells of the temporal bone act as resonators or as sound-absorbing chambers for the human ear. Pictures and diagrams of the apparatus used are given in the following pages.

In referring to the instrument I shall call the portion containing the vibrating diaphragms the head (fig. 4) and the portion which is next to the person the

Fig. 5.—The instrument.

Fig. 6.—The instrument in use.

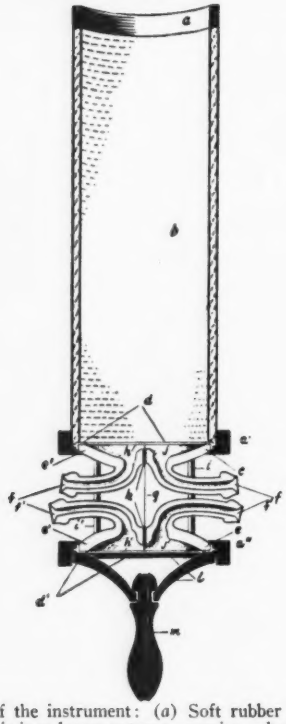


Fig. 7.—Diagram of the instrument: (*a*) Soft rubber shoulder cemented to a cardboard tube (*b*). This is to lessen extraneous noises when it is brought in contact with the ear piece of the audiometer.

(*a'*) Soft rubber shoulder to hold the cardboard tube (*b*) to the head of the instrument (see fig. 4).

(*a''*) Soft rubber shoulder to hold the ear piece to the head of the instrument.

(*b*) Cardboard tube 8 inches (20 cm.) in length and 2 inches (5 cm.) in diameter.

(*d*) Rim which screws onto shoulder (*e*) to hold diaphragm *h* in place.

(*d'*) Second rim to hold diaphragm *h'* in place.

(*e* and *e'*) Brass shoulders to which are attached diaphragms *h* and *h'*.

(*f*) Tubes leading to the space behind the distal diaphragm *h*. To these are attached the sound-absorbing tubes, the resonating tubes or the lead plugs, whichever are being used at the particular part of the experiment.

(*f'*) Tubes leading to the space behind the proximal diaphragm. To these are attached soft rubber tubes 2 feet (61 cm.) long to prevent any audiometric sounds from entering.

(*g*) Nickel-chromium alloy wire 0.0025 inch (0.064 mm.) in diameter and exactly 2 inches (5 cm.) long connecting diaphragm *h* to diaphragm *h'*. This is under only enough tension to keep it straight.

(*h* and *h'*) Diaphragms 0.001 inch (0.025 mm.) thick and 2 inches (5 cm.) in diameter, which are fastened to *e* and *e'*. These diaphragms must be of uniform thickness and free from all wrinkles or defects.

(*i* and *i'*) Metal bars which hold the head together.

(*j* and *j'*) Air space behind the distal and proximal diaphragms.

(*k*) Drill hole in a direct line passing through the proximal and distal frames. It was drilled in a straight line on a lathe and is 0.025 inch (0.6 mm.) in diameter.

(*l*) Rubber cone which collects the vibrations set up by diaphragm *h'* and centers these to the ear piece.

(*m*) Ear piece for detection of sound waves passing through the instrument from the audiometer. The ear piece (*m*) must not be forcibly held in the ear of the person undergoing this test, as it raises the threshold of the instrument, especially in the high tones. This is likely due to the air's being compressed in front of the distal diaphragm (*h*) and also to the changing of the space *j* into a closed space so that the vibrations build up in front of this diaphragm, interfering with its movement. The ear piece must therefore always be held in the external auditory canal of the person being tested so that a passage of escape is present around the hard rubber ear piece.

proximal portion (figs. 5 and 6) and that which is nearest the audiometer ear piece the distal portion (figs. 5 and 6).

It was found that the threshold of resistance in this instrument (fig. 7) is 50 decibels when the diaphragms are not connected (i. e., the instrument is assembled, but there is no wire connecting the two vibrating diaphragms), and any tone that approaches this level must be considered as not passing through the connected diaphragms but through the body of the instrument. It was also found that the diaphragms in this instrument must fall within definite limits of thickness and size

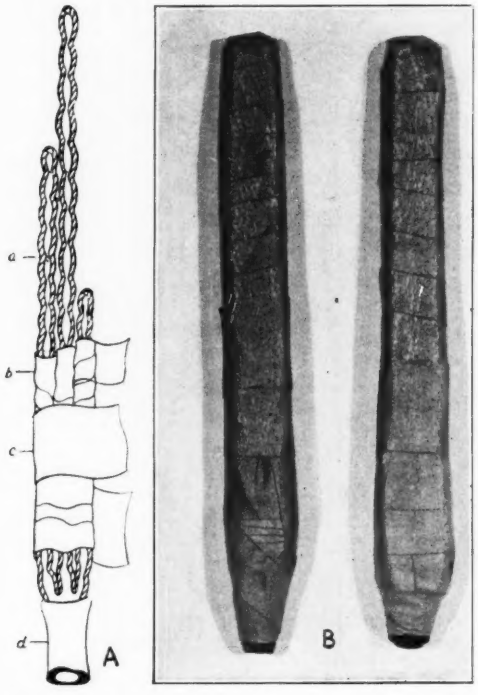


Fig. 8.—The sound-absorbing applicators are built as illsutrated: (*a*) Soft felt sewed so that it makes a series of air cells. (*b*) Covering of scotch tape. Each series of cells is bound with scotch tape, care being taken not to obliterate the lumen of the duct. There are several layers applied to each tube of cells to give them rigidity. (*c*) The tubes are held together by an outside binding of scotch tape. (*d*) Soft rubber tip so that these tubelike series of cells may be attached to the tubes (*f* in figs. 4 and 7) of the head of the instrument. It will be noted that each series of cells empties into a cavity to which is attached the rubber connecting tube (*d*).

and that the connecting wire must be of a definite length and thickness and under definite tension if the instrument is to give satisfactory responses. The best responses are given when diaphragms 2 inches (5 cm.) in diameter and 0.001 inch (0.025 mm.) thick are used. The fine wire that connects the diaphragms must

not exceed 0.0025 inch (0.064 mm.) in thickness and must be exactly 2 inches (5 cm.) long. The hole drilled through the frames behind the diaphragms, through which this wire passes, is 0.025 inch (0.6 mm.) in diameter. This causes a slight leak of sound but is necessary so that the wire will not touch the sides of the opening when it vibrates; otherwise it will not conduct the vibrations to the second diaphragm (fig 7). This drill hole was made on a lathe, and both holes were drilled at once so that they would be in direct line with each other and directly through the center of the head of the instrument.

The frames that hold the diaphragms are of cast brass and are of sufficient thickness so that they do not vibrate easily to the audiometer tones. These two

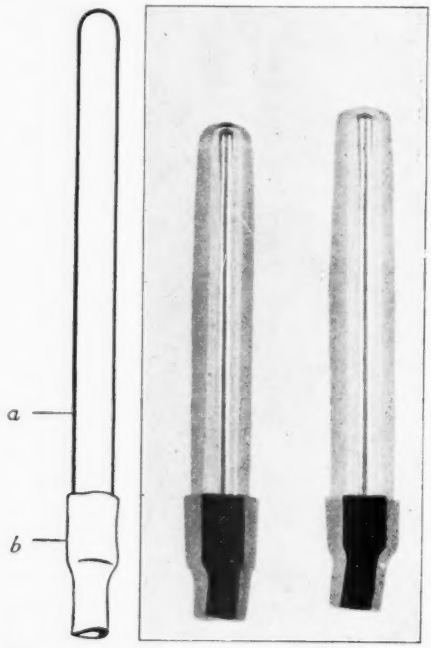


Fig. 9.—Resonating tubes are built as illustrated: (*a*) glass tube 7 inches (18 cm.) in length and 5/16 inch (about 8 mm.) in inside diameter; (*b*) soft rubber tubing by which these are attached to the distal tubes (*f* in figs. 4 and 7) of the head of the instrument.

frames are held together by posts which are solid enough not to allow distortion of the head in handling. The two frames are really modified phonendoscope heads held with the diaphragms facing away from each other. They are held so that the diaphragms are exactly 2 inches apart. The air space between them is occupied by the ducts (see figs. 4 and 5), to which are attached the sound-absorbing cells (fig. 8), the resonating tubes (fig. 9) or the lead stoppers (fig. 10), whichever are being used in the test at that time. This air space between the two frames that hold the diaphragms also allows dissemination of any sound

waves that might travel through the openings through which passes the wire that connects the two diaphragms. These holes are 0.025 inch in diameter and the wire only 0.0025 inch in diameter. The wire is nickel-chromium alloy and has great tensile strength. The tension on the wire is only sufficient to keep it taut.

The distal side of the head of the instrument is attached to a paper fiber tube 2 inches (5 cm.) in diameter and 8 inches (20 cm.) long. This tube is capped with a soft rubber ring at the distal end of the tube as it comes in contact with the ear piece of the audiometer, and the rubber reduces any extraneous noises. To the proximal end of the head of the instrument is connected a cone which collects the vibrations set up by the second diaphragm below and concentrates these to a hard rubber ear piece. The ear piece is put into the ear of a person with normal hearing, and an audiometer ear piece is fastened to the distal end of the cardboard tube. The vibrations that reach the ear must therefore pass through the head of the instrument and activate the two diaphragms. With this setup an audiogram is made using the frequencies 64, 128, 256, 512, 1024, 2048, 4096 and 8192 double vibrations per second. It was impossible to get this instrument to function properly to frequencies beyond 8192. To be sure that the sounds do not enter the metal tubes in the space behind the proximal diaphragm two rubber tubes 2 feet (61 cm.) long are attached to these tubes (fig. 5).

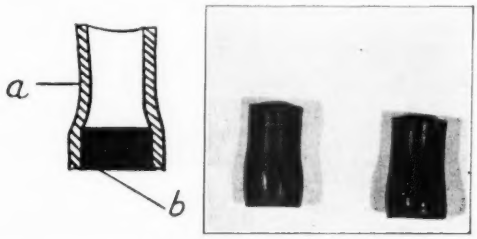


Fig. 10.—(*a*) Soft rubber tube to hold lead plug (*b*) tightly against the distal tubes (*f*) of the head of the instrument and so produce a closed space behind the diaphragm (*h*). This allows vibrations to build up in the space (*j*) and so interfere with and distort the excursions of the membrane (*h*). (The small letters *f*, *h* and *j* refer to figures 4 and 7.)

To the tubes behind the distal side of the head are attached the sound-absorbing tubes (fig. 8), the resonating tubes (fig. 9) or the lead stoppers (fig. 10), whichever are used in the test being done.

The sound-absorbing tubes are made up of a series of cells which are lined with soft felt. There are three series to each set of tubes, and these series are of different lengths (fig. 8*A*). The resonating tubes are narrow glass tubes which were tested for resonating quality beforehand. They have short pieces of rubber tubing over their mouths so that they may be attached to the tubes (fig. 9) behind the distal diaphragm. The lead stoppers (fig. 10) are also in short pieces of rubber tubing so that they may be applied to the tubes behind the distal diaphragm (fig. 7) and block these tubes, making the cavity behind the distal diaphragm essentially a closed space.

Four audiometric thresholds were recorded for each person in this experiment:

Threshold *A*, to establish the person's regular hearing.

Threshold *B*, obtained by using the instrument described and lead stoppers (fig. 10) against the metal tubes leading to the air space behind the distal diaphragm.

Threshold *C*, obtained with the same setup as *B* except that the lead stoppers were removed and the resonating tubes (fig. 9) were applied to the metal tubes leading to the air space behind the distal diaphragm.

Threshold *D*, obtained with the same setup as the two preceding thresholds except that, instead of the stoppers or the resonating tubes, sound-absorbing tubes (fig. 8) were attached to the metal tubes leading to the air space behind the distal diaphragm.

These tests are recorded in figure 11. It will be noted that loss of sounds passing through the instrument is considerably less when the sound-absorbing mechanism is attached to the metal tubes leading to the

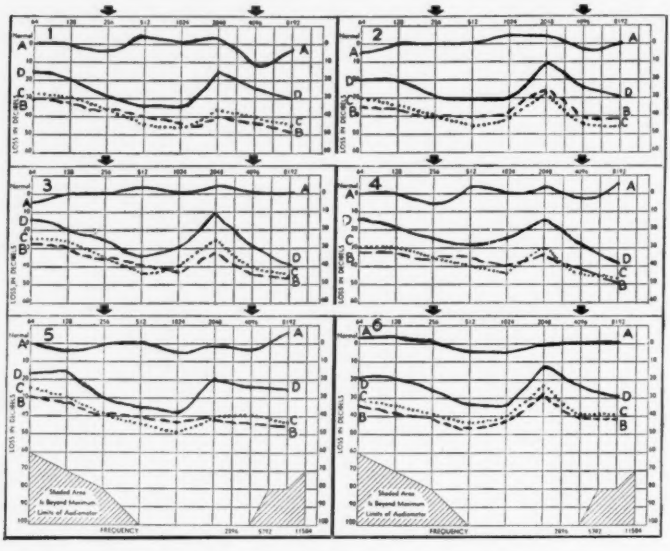


Fig. 11.—When the apparatus described was used, audiograms were obtained that show the energy in decibels necessary to activate the diaphragms and produce threshold hearing for persons with normal hearing: (*1*) M. P.; (*2*) G. P.; (*3*) C. M.; (*4*) B. J.; (*5*) H. A.; (*6*) O. G. These six people were well acquainted with the audiometer and their responses should be accurate.

The curves represent: *A*, regular audiometric readings; *B*, readings when the instrument was used with lead stoppers against the metal tubes leading to the air space behind the distal diaphragm; *C*, readings when the instrument was used with resonating tubes attached to the metal tubes leading to the air space behind the distal diaphragm; *D*, readings when the instrument was used with sound-absorbing tubes attached to the metal tubes leading to the air space behind the distal diaphragm.

air space behind the distal diaphragm than when the stoppers or the resonating chambers are attached to these tubes. This definitely shows that the vibrations of the diaphragm in the distal frame of the head of

the instrument were interfered with by the sound waves that built up behind it. The same thing will happen to the vibrations of the ear drum if the cells of the mastoid process are blocked off from the middle ear, and this explains why the artificial ear drums improve the patients' hearing much more when the aditus ad antra are clear.

The difference of the decibel readings in each of these audiograms gives a rather graphic idea of what sound waves building up behind a vibrating membrane will do. Nature has supplied a sound-absorbing mechanism in the air cells of the temporal bone to prevent this interference and distortion of sounds in the middle ear. In testing this instrument it was noted that distortion developed when the lead stoppers were used over the distal tubes (fig. 10) between the two diaphragms. This is to be expected, as sound waves build up and interfere with one another. The distortion was most pronounced at 64 double vibrations, producing a tone some octaves higher. It usually was heard before the true tone was audible. When the sound-absorbing attachments were used instead of the lead stoppers there was no interference that could be detected.

The air cells have been destroyed in mastoidectomies with no consideration as to their function. In younger persons who have undergone simple mastoidectomy nature attempts to reform these cells, but in older persons, if the mastoidectomy has been fairly complete, the partial loss of cellular function is permanent. After a simple mastoidectomy in which the antrum has been left intact many of the cells left in the mastoid process at operation will continue to function, and good hearing may follow the operation. All the cells that connect with the middle ear and the antrum are never removed in simple mastoidectomy, so that a complete loss of cellular function never follows this operation. The slight loss of hearing following simple mastoidectomy in many patients is undoubtedly due to the loss of the function of the mastoid process described. Sclerotic mastoid processes may have satisfactory sound-absorbing qualities as long as there is cellularization. Persons whose mastoid processes are completely sclerotic, even if they have perfectly functioning cochleas, undoubtedly have a definite impairment of hearing due to the fact that there is sound interference in the middle ear lessening the force of the excursions of the tympanic membrane.

In the fenestra nov-ovalis operation many of the cells of the mastoid processes are sacrificed and the antrum is sealed off by the flap, so that the only sound-absorbing cells left are those that open into the middle ear directly. This produces interference reducing the excursions of the drum membrane and hence the acuteness of hearing that should be obtained in the ear operated on. This is especially true if there is an active fistula reaction when the drum membrane is touched.

If the drum membrane is bound down with adhesions over the prominence of the canal for the facial nerve, the sound interference in the middle ear will have little or no effect on the hearing, which in this event will be poor anyway.

Day [3] advised otologists most earnestly not to do the complete mastoidectomy when performing fenestration, as the enlarged cavity would give rise to an echo phenomenon. The mastoidectomy cavity is much too small to produce an echo,[1] but the phenomenon he mentioned is undoubtedly produced by the vibrational interference and distortion of sound that occur in the middle ear in consequence of the destruction of the sound-absorbing air cells of the mastoid process.

OBSERVATIONS THAT SUPPORT THE THEORY THAT SOUNDS ARE ABSORBED IN THE AIR CELLS

In 1945 Lempert [4] claimed that in 20 per cent of cases of so-called "frank nerve deafness" an improvement of hearing resulted from fenestration of the labyrinth. It is likely that there was a misjudgment of the cochlear reserve in these cases. Lempert depended at that time on the bone conduction test to give him an estimation of the so-called cochlear reserve. The bone conduction test does not give a correct estimation of the cochlear reserve in all cases, and further evidence that errors of classification are likely is given by some of the audiometric results of Lierle and Reger.[5] They reported audiograms of deafened persons showing markedly increased acuity for bone conduction and also audiograms showing disproportionate decrease in acuity for bone conduction.

In doing a bone conduction test, one usually places the bone conduction tip over the mastoid bone. Now if the mastoid process is functioning well, the sound produced by the bone conduction tip may be absorbed to a greater extent than usual by the cells of the mastoid process and not reach the cochlea as forcefully as it should. If the cells have heavy walls, the sounds may not be absorbed to as great an extent as usual and may give the impression of greatly increased bone conduction or high cochlear reserve. In reality the sound waves conducted through the mastoid cells in either case have been distorted.

---

3. Day, K. M.: Appraisal of Fenestration Operation: Report of One Hundred Cases, Arch. Otolaryng. **44**:547 (Nov.) 1946.

4. Lempert, J.: Lempert Fenestra-Nov-Ovalis with Mobile Stopper: New Advance in Surgical Treatment for Clinical Otosclerosis Evolved as Result of Research Study of One Thousand Cases in Which Fenestration Has Been Performed During Last Seven Years, Arch. Otolaryng. **41**:1 (Jan.) 1945.

5. Lierle, D. M., and Reger, S. N.: Correlations Between Bone and Air Conduction Acuity Measurements Over Wide Frequency Ranges in Different Types of Hearing Impairment, Laryngoscope **56**:187, 1946.

The cellular absorption of sound must be taken into account in these cases of so-called "frank nerve deafness," also in cases of disproportionate increase of bone conduction. Undoubtedly, the cases reported by Lempert were those in which the cellular absorption of sound was sufficient to give a paradoxic impression of the cochlear reserve, and were not really cases of nerve deafness at all.

I have noticed that in my patients whose labyrinths have been successfully fenestrated, the Weber test sound is referred to the ear operated on, and the bone conduction is improved as compared with the preoperative bone conduction. This is most likely due to the fact that many of the air cells of the mastoid process were destroyed during the fenestration. In my postoperative patients these two tests give the most pronounced results in those in whom I have removed most of the air cells. Undoubtedly, these results of the Weber test and the bone conduction test are due to the lack of absorption of the sound waves, which is due to the destruction of part of the air cells. In many of the patients on whom I have done fenestration of the labyrinth there is a progressive postoperative nerve type of degeneration, which may be due to an otosclerotic lesion advancing around the cochlea or may be due to trauma, as the protective faculties of the conductive apparatus have been destroyed at operation and the cochlea is exposed to sound trauma which may cause degeneration. In postoperative patients in whom the Weber test reverses itself (sound referred to the ear not operated on) there has already developed damage of the nervous apparatus, and this is further manifested by a higher threshold in the bone conduction audiometric reading. The closing of the fenestra does not alter the postoperative reference of the Weber test or the higher level of bone conduction so long as the cochlea is not damaged. To summarize—the Weber test sound is referred to the postoperative ear whether the fenestra is open or closed as long as the cochlear function is good, and the bone conduction threshold is lowered in the ear postoperatively whether the fenestra is open or closed, provided the cochlea has not been damaged. This is undoubtedly explained by the lessened absorption of sound waves following destruction of many of the air cells of the mastoid process.

After simple mastoidectomy the Weber test sound is always referred to the ear operated on, provided the cochlear function is good in this ear. This also is explained by destruction of the air cells of the mastoid process operated on and lessening of the sound absorption of this ear.

SUMMARY

The cells of the mastoid process are of great importance in hearing, for they act as sound-absorbing structures, absorbing the sound vibra-

tions that otherwise would build up behind the drum membrane and interfere with and distort its excursions. Undoubtedly, many cases of so-called "frank nerve deafness" diagnosed by tests of bone conduction are not cases of nerve deafness, and the audiograms are misleading. The air cells of the mastoid process may absorb vibrations when a bone conduction test is made and give an erroneous reading, or again, in cases in which heavy septums are present, may conduct sound waves much better than in the average case and thus suggest that the cochlear reserve is higher than it really is.

CONCLUSIONS

1. The air cell system of the mastoid process acts as a sound absorber to prevent sound waves from building up in the middle ear and interfering with the excursions of the drum membrane, distorting the transmitted sound waves.

2. The echo phenomenon reported by Day is undoubtedly due to the distortion that occurs in ears on which the fenestration operation has been performed, owing to loss of many of the sound-absorbing air cells of the mastoid process.

3. The bone conduction method of estimating the so-called "cochlear reserve" is not always dependable and may be misleading.

4. The present fenestration technic will have to be revised to preserve the air cells of the mastoid process, or the hearing threshold of patients undergoing this operation will never permanently approach the normal level.

115 East Sixty-First Street.

ANTRAL WINDOW IN THE MIDDLE MEATUS

Experiments and Presentation of Cases in Which an Antral Window Was Made in the Middle Meatus of the Human Subject and No Additional Surgical Procedures Were Performed

W. W. WILKERSON Jr., M.D.
NASHVILLE, TENN.

THE clinical research presented in this thesis was undertaken neither for the purpose of proving that the opening of a window into the maxillary antrum through the middle meatus is physiologically correct nor for the purpose of advocating such a procedure for drainage of the sinus. Rather, it was a matter of pure research to determine what occurs in an antrum and adjacent structures after the making of a middle meatal window. Pertinent experiments had been done on animals but not on the human subject.

The work discussed in this paper was done with some trepidation despite my recognition of the work of men who had adopted this surgical procedure as one of choice. Then, too, I had made an antral opening through the middle meatus before the publication of the excellent experimental work of Hilding, Proetz, Van Alyea, Lucas, Lierle and others, with good results. However, without the encouragement of some of the leading members of the Triological Society, it would have seemed unwise to reopen this controversial problem.

HISTORICAL REVIEW

Because of the dearth of literature concerning the subject of making the antral window through the middle meatus, there are few salient facts to quote.

Ostrum [1] was perhaps the first in this country to advocate forcefully the making of middle meatal windows. Brawley and Pierce, in discussing Ostrom's essay, voiced their approval of his method of ventilating and draining the maxillary sinus.

From the Department of Otolaryngology, Vanderbilt School of Medicine.

Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society.

1. Ostrom, L.: Ventilation Rather Than Drainage Essential for the Cure of Sinus Disease, with Special Notes on the Antrum of Highmore, Illinois M. J. **24**:347-352 (Dec.) 1913.

Réthi,[2] Freer,[3] Sluder,[4] Canfield[5] and Hirsh[6] made large compreprehensive antral windows by removing the antral wall of both the inferior and the middle meatus but without removing the inferior turbinate bone.

Sewall[7] advised that one should, as a routine, remove the middle meatal wall in surgical treatment of the ethmoid and sphenoid sinuses when doing radical antrotomy. He further advised that the middle meatal wall be removed when isolated disease of the antrum is present.

Hilding,[8] in discussing the results of his experimental work on the maxillary sinus in rabbits, stated, "The experiments indicate that windows made at or near the ostium interfere so seriously with the normal sinus physiology that the sinus becomes infected as a result. All three of those in which the window was made at the ostium became infected postoperatively." He added, "It cannot be concluded from these experiments that exactly the same results would occur in the sinuses of other species or in man."

Proetz[9] stated, "To regard the ostium simply as an opening into the sinus, which can be roughly handled and even enlarged with impunity, is to court failure in establishing hygiene of the region."

Zuckerkandl[10] suggested that the middle meatus be used for an opening into the maxillary sinus because of its membranous structure.

Siebenmann[11] systematically made openings into the antrum through the middle meatus and reported good results. He made his first opening

2. Réthi, L.: Eine Radicaloperation der Kieferhohle von der Nase her zur Behandlung hartnöckiger Empyeme, Wien. med. Wchnschr. **51**:2436-2439, 1901; Die Radikaloperation der Kieferhöhleneiterungen von der Nase her, Wien. klin. Wchnschr. **21**:142-149, 1908.

3. Freer, O. T.: The Antrum of Highmore: The Removal of the Greater Part of Its Inner Wall Through the Nostril, for Empyema, Laryngoscope **15**: 343-349 (May) 1905.

4. Sluder, G.: A Modified Mikulicz Operation Whereby the Entire Lower Turbinate Is Sawed in Intranasal Operations on the Antrum of Highmore, with Presentation of a Patient, Laryngoscope **19**:904-910, 1909.

5. Canfield, R. B.: The Submucous Resection of the Lateral Nasal Wall in Chronic Empyema of the Antrum, Ethmoid and Sphenoid, J. A. M. A. **51**: 1136-1141 (Oct. 3) 1908.

6. Hirsch, O.: Wien. med. Wchnschr. **58**:1550-1554 (July 4) 1908.

7. Sewall, E. C.: Diagnosis and Treatment of Chronic Maxillary Sinus Infection, Arch. Otolaryng. **8**:405-419 (Oct.) 1928.

8. Hilding, A. C.: Experimental Sinus Surgery: Effects of Operative Windows on Normal Sinuses, Ann. Otol., Rhin. & Laryng. **50**:379-392 (June) 1941.

9. Proetz, A. W.: Essays on the Applied Physiology of the Nose, St. Louis, Annals Publishing Company, 1941, p. 356.

10. Zuckerkandl, E.: Normale und pathologische Anatomie der Nasenhöhle und ihrer pneumatischen Anhänge, Leipzig, W. Braumüller, 1893.

11. Siebenmann, F.: Beitrag zur Lehre von der Entstehung und Heilung kombinierter Nebenhöhleneiterungen der Nase, Monatschr. f. Ohrenh. **46**:656-661, 1912.

in 1889 and stated that he was able to clean the edematous membranes from the antrums. The latter statement I doubt.

Onodi [12] dilated the ostium with the aid of a trocar.

Bayer [13] removed the pars membranacea with a galvanocautery.

Kubo [14] used that procedure and stated that the window stayed open and that the patients were taught to irrigate their own sinus through this opening.

About ten years ago a member of the department of otolaryngology of Washington University operated on 5 patients, making a window through the middle meatus and doing no other surgical work. The end results were reported as being excellent.

Hajek [15] was satisfied with the results which he obtained with middle meatal windows.

QUESTIONNAIRE

In order to obtain accurate statistical data from rhinologists, the following questionnaire was mailed to each member of the Triological Society:

1. Have you ever made a permanent opening into the antrum through the middle meatus?
2. Diagnosis?
3. Approximate number of cases?
4. Approximately when did you do this the first time?
5. What was the age group?
6. Technic employed?
7. Have these patients had any stasis of antral secretion?
8. Have you made any subsequent roentgenograms? If so, what did they reveal?
9. End results?
10. May I quote you?

Four hundred and ninety-one copies of this were sent, and 366 replies were received. Two hundred and thirty-six physicians stated that they had never performed that operation. Several went further and stated that they were opposed to any traumatizing of the tissues within the middle meatus. Ninety-four stated that they had performed fenestration of the antrum through the middle meatus. (Their reports are summarized in table 1.) In addition to the 94 who reported cases,

12. Onodi, A.: Die Eröffnung der Kieferhöhle im mittleren Nasengange, Arch. f. Laryng. u. Rhin. **14**:154-160, 1903.

13. Bayer, C.: Beitrag zum Studium und zur Behandlung des Empyems der Highmoreshöhle, Deutsche med. Wchnschr. **15**:187-190, 1889.

14. Kubo, I.: Ueber die supraturbinale Eröffnung bei der Sinusitis maxillaris chronica, Arch. f. Laryng. u. Rhin. **26**:351-356, 1912.

15. Hajek, M.: Pathology and Treatment of the Inflammatory Diseases of the Nasal Accessory Sinuses, translated by J. D. Heitger and F. Hansel, ed. 5, St. Louis, C. V. Mosby Company., 1926, vol. 1.

other men stated that they had performed the operation, but they gave such meager information that the reports of results were of no scientific value.

Forty additional members of the Triological Society reported that they had made an antral window through the middle meatus either with or without a window in the inferior meatus when doing a radical operation on the maxillary sinus. According to those reports, 97 per cent of their patients received a better than average result.

TABLE 1.—*Summary of Data Supplied by Members of the Triological Society in Reply to a Questionnaire*

Physicians quoted	84
Year of earliest reported antral window made through middle meatus	1902
Cases reported, some bilateral	1,376
Age range	?
Maxillary sinusitis:	
Acute	250
Subacut	212
Chronic	885
Technic	
Electrocoagulation	5
Punch	596
Rasp	4
Combination of punch and rasp	512
Postoperative retention of secretion	
Definite stasis	77
Little stasis	326
No stasis	597
Postoperative roentgen observations	
Thickened membrane	300
Slight clouding	36
Clouding	5
Clear	76
End result	
Excellent	118
Good	641
Fair	244
Poor	69

ANATOMY

Since the anatomy of the maxillary sinuses, together with that of the anomalies, has been thoroughly described many times in the literature, I shall limit my discussion to a few of the important facts.

The maxillary sinus opens on the floor or the lateral wall of the infundibulum posteriorly. The ostium may be merely an opening but is usually a passage simulating a tubule several millimeters in length. The nasal end of this tubule may be horizontal, vertical or oblique. The tubule usually takes a downward and outward course between the bulla and the uncinate process of the ethmoid bone to open into the maxillary sinus. The tubule varies greatly in length, direction and shape. Though its general direction is downward and outward, it may be horizontal or vertical or a combination of the four directions. Neither

its length nor its diameter is constant, as shown by the fact that various authors have observed different dimensions in the series of skulls which they have studied.

Zuckerkandl [10] stated that in studying 300 specimens he found the largest ostium to be 19 by 5 mm. and the smallest to be 3 mm. in diameter. Schaeffer,[16] in examining 122 specimens, found the tubule to vary in diameter from 1 to 6 mm. and in length from 1 to 22 mm. Myerson [17] stated that in the sinuses which he studied the diameter of the tubule varied from 1 mm. to 13 by 11 mm. However, the average diameter of the ostium in the average specimen is less than 5 mm.

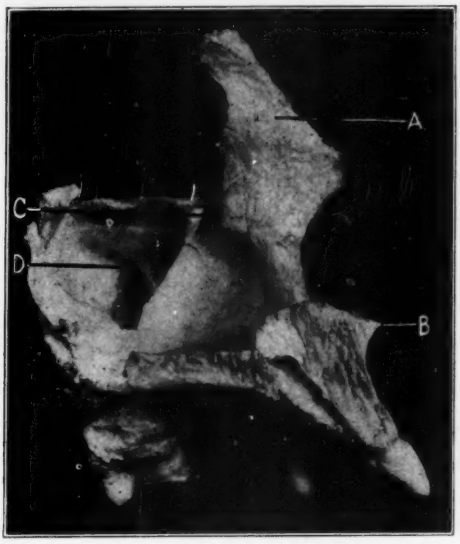


Fig. 1.—The nasal surface of the left superior maxilla. *A* indicates the ascending process; *B*, the anterior nasal spine; *C*, the lacrimal groove; *D*, the hiatus maxillaris.

The accessory ostium is merely an opening in the pars membranacea, located in the posterior portion of this anatomic entity. It probably occurs in 30 to 40 per cent of the specimens. It varies in size but is usually much smaller than the normal ostium.

16. Schaeffer, J. P.: The Nose, Paranasal Sinuses, Nasolacrimal Passageways, and Olfactory Organ in Man: A Genetic, Developmental, and Anatomico-Physiological Consideration, Philadelphia, P. Blakiston's Son & Co., 1920.

17. Myerson, M. C.: The Natural Orifice of the Maxillary Sinus: Anatomic Studies, Arch. Otolaryng. **15**:80-91 (Jan.) 1932.

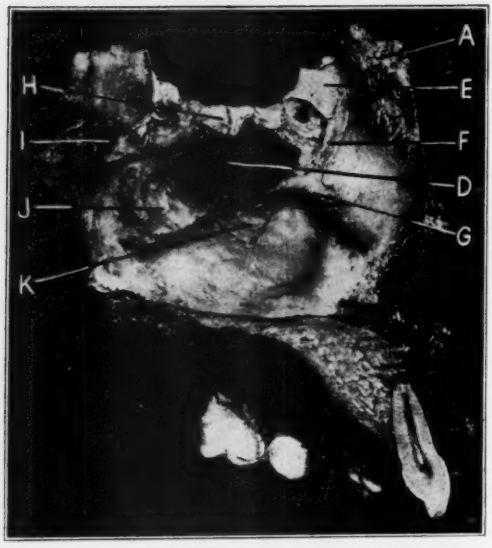


Fig. 2.—The nasal surface of the left superior maxilla, showing the palate bone and the maxillary process of the turbinal bone filling in a portion of the hiatus maxillaris. *A* indicates the ascending process; *E*, the lacrimal bone; *F*, the lacrimal; *D*, the hiatus maxillaris; *G*, the attachment of the turbinal bone; *H*, the body of the maxilla forming part of the floor of the ethmoid sinus; *I*, the sphenopalatine foramen; *J*, the perpendicular plate of the palate bone; *K*, the maxillary process of the turbinate bone (outlined for clarity).

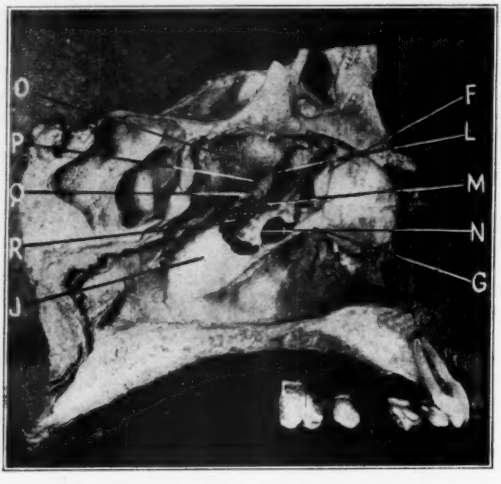


Fig. 3.—Structure of the lateral nasal wall, showing the hiatus maxillaris further filled in by the bulla and the uncinate process of the ethmoid bone. The middle turbinate has been cut away at its attachment. A dotted line shows the area excised in the middle meatus window operation. *O* indicates the ethmoid labyrinth; *P*, the attachment of the middle turbinate; *Q*, the bulla; *R*, the pars membranacea; *J*, the perpendicular plate of the palate bone; *F*, the lacrimal canal; *L*, the hiatus semilunaris; *M*, the ostium of the maxillary sinus; *N*, the uncinate process; *G*, the attachment of the turbinate bone.

The tissues around the ostium are loose and cavernous in type, similar to those around the turbinate bone.

SURGICAL ANATOMY

The pars membranacea is bounded above by the horizontal plate of the maxilla, below by the superior portion of the inferior turbinate bone, anteriorly by the uncinate process and the lacrimal bone and posteriorly by the palate bone.

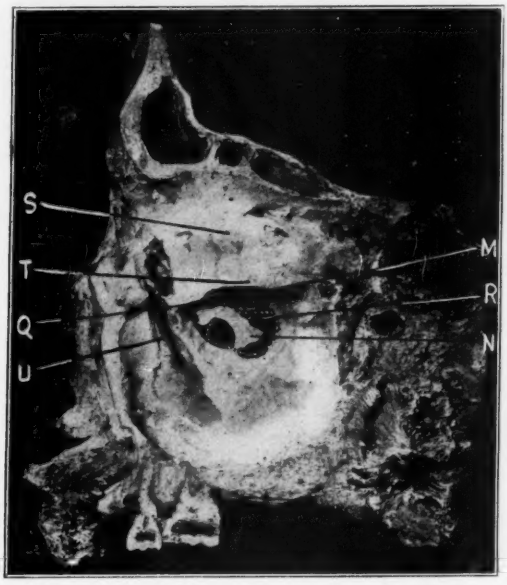


Fig. 4.—Section showing the lateral surface of the nasal wall of the left antrum. The dotted line shows the area excised in the middle meatus window operation. *S* indicates the lamina papyracea; *T*, the orbital plate of the superior maxilla; *Q*, the bulla; *U*, the nasolacrimal duct; *M*, the ostium of the maxillary sinus; *R*, the pars membranacea (cut away); *N*, the uncinate process.

The ostium is located in the superior portion of the pars membranacea. It is therefore necessary in making a middle meatal window to make it from the ostium downward. The vessels and the nerves which enter the antrum in the region of the ostium are not located within a radius of 1 cm. of the ostium itself. Hence a window might be made in this area without damaging these vital structures. In studying a series of 18 specimens it was found that the average size of the pars membranacea was 7 by 16 mm. Vertically this membrane varies from

5 to 10 mm., while anteroposteriorly it varies from 12 to 28 mm. The maxillary ostium was found to be from 8 to 17 mm. from the lacrimal canal. It is important to note that while the average distance from the maxillary ostium to the lacrimal canal is 10 mm., the lacrimal canal is only 5 mm. from the anterior border of the pars membranacea. Therefore, in making a middle meatal window the tissues removed should be

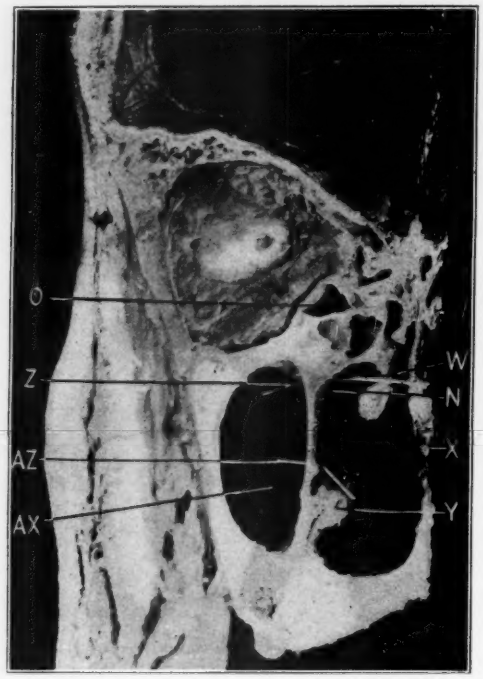


Fig. 5.—Frontal section cut just behind an accessory ostium. *O* indicates the ethmoid labyrinth; *Z*, a straw in the ostium; *AZ*, a straw in an accessory ostium; *AX*, the maxillary sinus; *W*, the middle turbinate; *N*, the uncinate process; *X*, the septum; *Y*, the inferior turbinate.

inferior and posterior to the ostium. While the distance from the posterior edge of the pars membranacea to the posterior palatine canal was not accurately measured in the work for this thesis, its average distance is approximately 1 cm. Therefore, one need not be concerned with this structure and its contents in making a middle meatal window.

PHYSIOLOGY

The physiology of the drainage of the maxillary sinus shows that drainage is established by ciliary action and not by gravity. The cilia

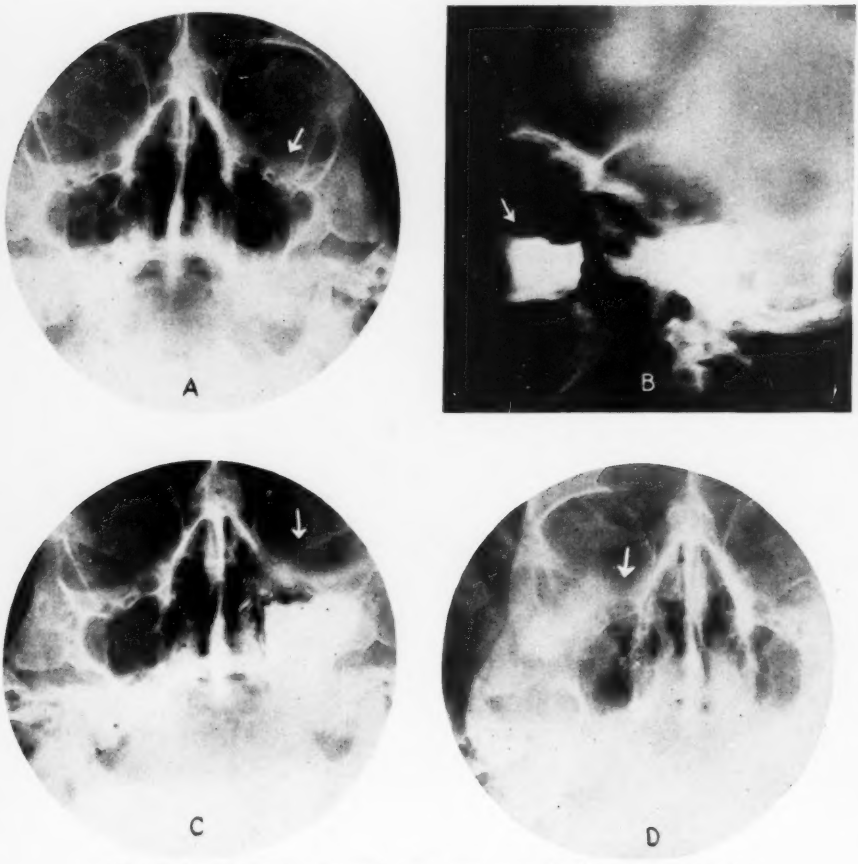


Fig. 6 (case 2).—*A*, preoperative roentgenogram showing increased density along the lateral walls of the antrums. *B*, lateral view after injection of iodized oil, showing no filling defect of the right antrum. *C*, frontal view, showing no filling defect. The antrum was treated by the middle meatus window operation. *D*, roentgenogram taken six and one-half months after operation. It shows increased density of the right antrum. No improvement was shown by the roentgen examination.

are slender motile rods and are situated close together on the surface of the epithelium. The free end of each cilium is thicker than that por-

tion which penetrates into the columnar epithelium, the lining membrane. The cilia beat in concert; they rest for a short time, and then resume their work. The effective stroke is in one direction only. It has been

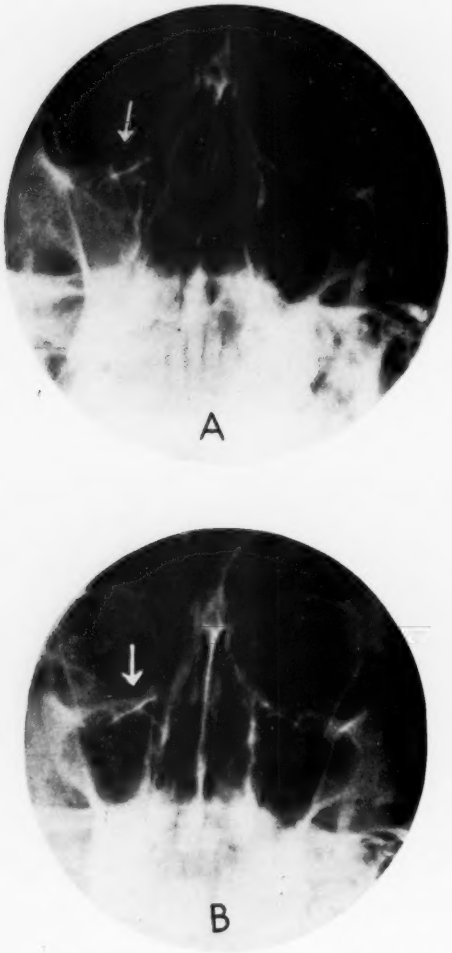
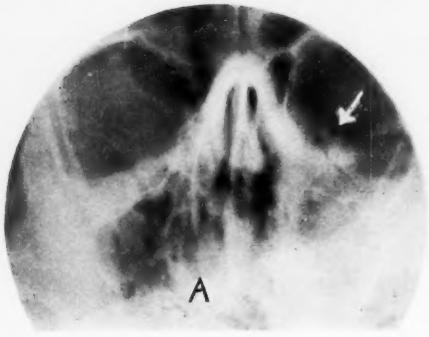


Fig. 7 (case 3).—*A*, preoperative roentgenogram showing increased density of the left antrum. The left antrum was treated by the middle meatus window operation. *B*, roentgenogram taken six and one-half months after operation. The left antrum reveals slightly increased density. Improvement is noted.



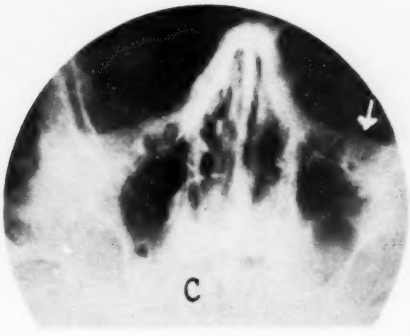


Fig. 8 (case 4).—*A*, preoperative roentgenogram showing increased density of right antrum. *B*, roentgenogram made after injection of iodized oil, showing a large filling defect of the right antrum. The antrum was treated by the middle meatus window operation. *C*, roentgenogram made eight months after operation. There is little increase of density in the right antrum. Improvement is noted.

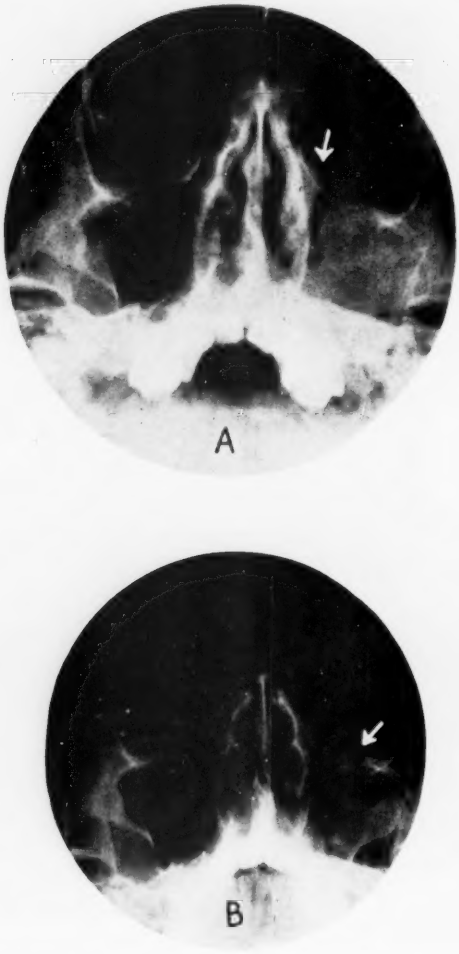


Fig. 9 (case 5).—*A*, preoperative roentgenogram showing increased density of the right antrum. The antrum was treated by the middle meatus window operation. *B*, roentgenogram made seven months after operation. The right antrum is slightly cloudy. Improvement is noted.

stated that the cilia will empty a maxillary sinus within a few hours if the substance is of low viscosity.

Hilding,[18] using india ink in his experiments, reported on the course of the currents in the frontal sinus of a dog. These currents proceeded in

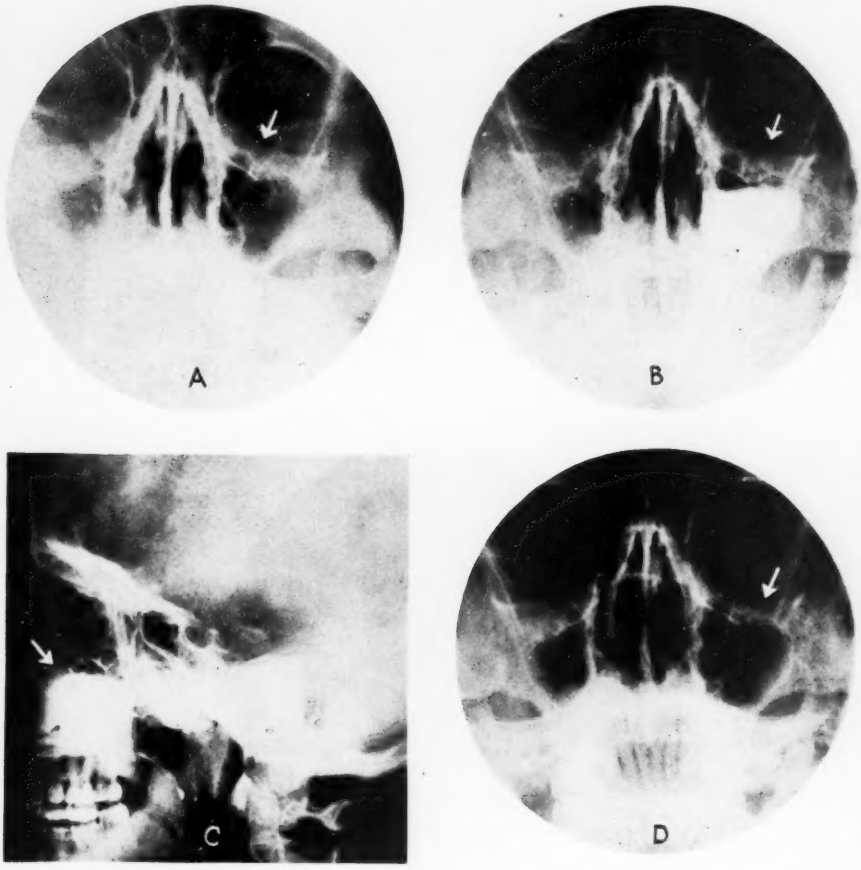


Fig. 10 (case 6).—*A*, preoperative roentgenogram showing increased density of the antrums. *B* and *C*, roentgenograms made after injection of iodized oil, showing no filling defect of the right antrum. The antrum was treated by the middle meatus window operation. *D*, roentgenogram made ten months after operation. It shows no increase in the density of the right antrum. Improvement is noted.

18. Hilding, A. C.: The Influence of Ciliary Activity on the Bacteriology of the Nose: Direction of Ciliary Currents in the Frontal Sinus of a Dog, Proc. Staff Meet., Mayo Clin. **6**:320-322 (May 27) 1931.

a straight line from the deepest portion of the frontal sinus, and from the other portions of the frontal sinus the currents proceeded in a slightly curved course of the ostium. He stated that the rate of flow

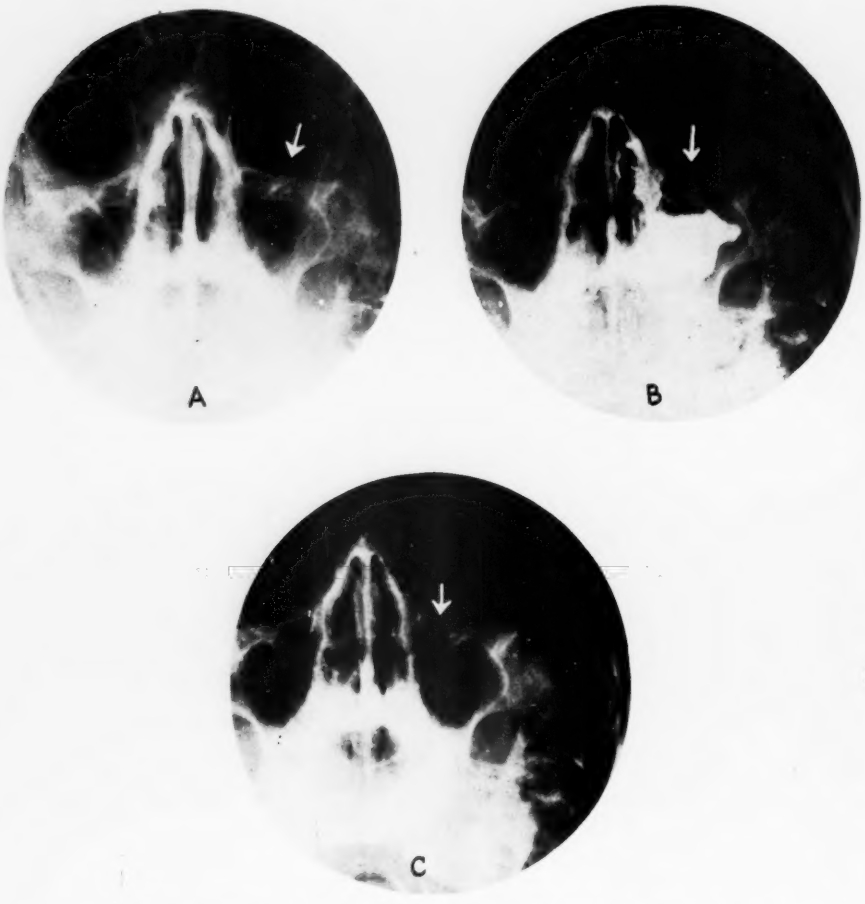


Fig. 11 (case 7).—*A*, preoperative roentgenogram showing increased density of the right antrum. *B*, roentgenogram made after injection of iodized oil. Note the filling defect of the right antrum. The antrum was treated by the middle meatus window operation. *C*, roentgenogram made seven months after operation. It shows an apparently normal right antrum.

varied between 2 and 8 mm. per second, the greater speed being attained as the ostium was approached.

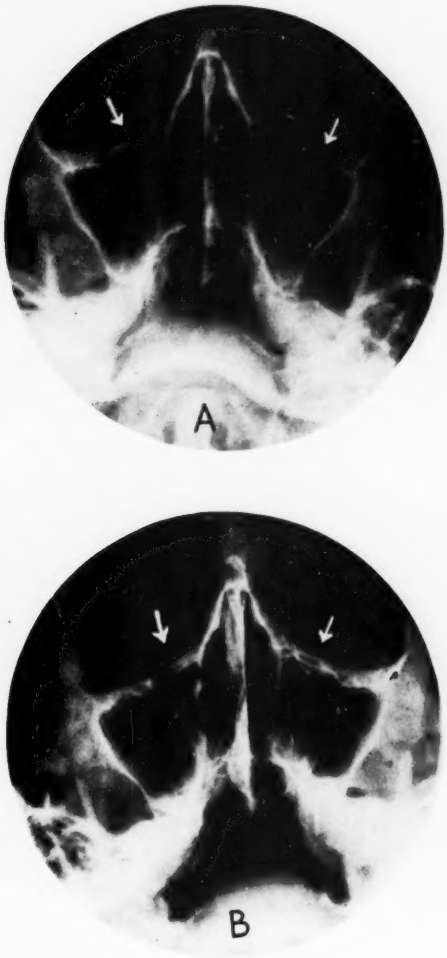


Fig. 12 (cases 8 and 9).—*A*, preoperative roentgenogram showing little increase of density of the antrums. Each antrum was treated by the middle meatus window operation. *B*, roentgenogram taken six months postoperatively. The antrums appear normal. These roentgenograms photographed poorly.

Proetz,[19] in experimenting with ciliary action, found that particles would go around any obstruction placed in their path. He further noted that a window opened in the antrum through the inferior meatus caused the particles to be carried around the opening to the ostium.

Lucas,[20] experimenting on ciliary action in the maxillary sinus of the rhesus monkey, observed that the particles were propelled in a spiral route toward the ostium. He felt that this increased the capacity of the cilia for moving larger amounts of material.

Normally the mucus lies against the membrane as a very thin coat and moves constantly toward the ostium. When the ostium is blocked and the cilia cease to function, the mucus tends, presumably by gravity, to flow downward.

Hilding [21] has shown that little air is exchanged between the nose and the antrums by way of the ostiums. He stated that in hyperventilation most of the exposed epithelium became thickened, lost its cilia and assumed the characteristics of stratified squamous epithelium. The lining membrane thickened, and the number of glands increased. The nasal mucosae of the open nares of a dog and a rabbit were found to react entirely differently.

After the antral ostium becomes closed, the absorption of the air that is within the antrum creates a partial vacuum, which produces congestion and edema, and transudation of the fluid follows. The tissues around the ostium are more susceptible to outside influences than the lining membrane of any other portion of the antrum. Therefore, the ostium tends to become swollen; in consequence of the swelling the exchange of air is prevented and the ciliary action stopped before the lining membrane of the remainder of the antrum is involved. To maintain a healthy antrum the ostium must be patent.

PRESENTATION OF CASES

Thirty-two patients were operated on for chronic or subacute maxillary sinusitis, although several other sinuses were infected, as was proved clinically and roentgenologically. The ages of the patients whose cases are reported ranged from 16 to 59, the average being 31½ years. There were 17 females and 15 males.

Of the 30 patients, only 11 returned for the final examination despite constant urging and pleading. (Thirteen cases are reported, as 2 patients were operated on bilaterally.) The patients who refused to return stated that they were having no trouble and were feeling fine.

19. Proetz, A. W.: The Displacement Method of Sinus Diagnosis and Treatment: A Practical Guide to the Use of Radiopaques in the Nasal Sinuses, St. Louis, Annals Publishing Company, 1931.

20. Lucas, A. M.: The Nasal Cavity and Direction of Fluid by Ciliary Activity in Macacus Rhesus (Desm.), Am. J. Anat. **50**:141-177 (March) 1932.

21. Hilding, A. C.: Experimental Surgery of the Nose and Sinuses: Changes in Morphology of the Epithelium Following Variations in Ventilation, Arch. Otolaryng. **16**:9-18 (July) 1932.

It is interesting to note that in 1 case the patient when first seen had in addition to sinusitis a complete congenital bony occlusion of the posterior choanae. The occluding wall was removed before the antral window was made.

The patients were examined prior to or during the course of treatment and were found to be in good health generally. The serologic examinations gave negative results.

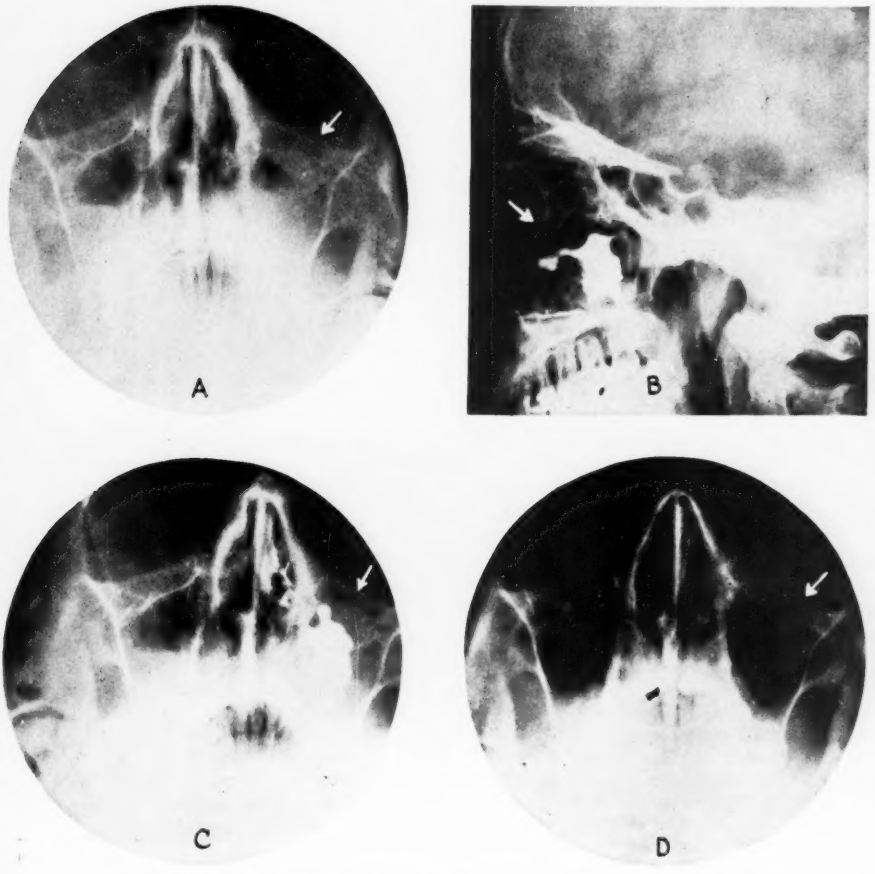


Fig. 13 (case 10).—*A*, preoperative roentgenogram showing little increase of density of the antrums, more marked on the right. *B* and *C*, preoperative roentgenograms made after injection of iodized oil. Note the large filling defect of the right antrum. The right antrum was treated by the middle meatus window operation. *D*, roentgenogram made nine months after operation. The right antrum appears normal.

PROCEDURE OF EXAMINATION

The patient is examined to obtain information on the following points:

1. History and age.
2. Type of discharge, if present.
3. Gross pathologic changes of nasal mucous membrane.
4. Appearance of nasopharynx as viewed with:
   (*a*) Mirror
   (*b*) Nasopharyngoscope
5. Interpretation of roentgenograms.
6. Size and shape of antrum as shown by the roentgenograms.
7. Type of naris.
8. Position of middle turbinate bone:
   (*a*) Crowded against the lateral wall
   (*b*) Normal position
   (*c*) Protruding toward the nasal septum
9. Deviations of nasal septum.
10. Appearance of middle meatus as viewed with nasopharyngoscope.
11. Clinical evidence of an allergic reaction.
12. Smears for eosinophils.
13. Return on irrigation of antrum.
14. Cultures made of antral washings.
15. Interpretation of roentgenogram made after injection of iodized poppyseed oil 40 per cent.

SURGICAL PROCEDURE

With cocaine mud being used to produce anesthesia, the natural ostium was located, when possible, with a curved olive-tipped probe. The distance from the ostium to the ala was then measured.

A Myles punch, rather triangular in shape, was introduced into the middle meatus by using the aforementioned measurement, the tissues covering the middle turbinate bone being pushed aside as needed.

The male blade was opened and was introduced into the antrum through the pars membranacea. This was done by forcing the blade through these tissues.

An opening approximately 5 by 8 mm. was made in each case. In some instances this required using the punch two or three times.

An attempt was made to remove the normal ostium in each case. However, when the ostium could not be located, an opening was made in that region.

During the operation the patients complained of little if any pain. Practically no bleeding occurred. The surgical work was performed rapidly, and the procedure in each case was simple. No rasping was done, and, with the use of a cleancutting punch, all edges were left smooth and even.

Trauma of the intranasal structures was avoided as much as possible. In no case was the middle turbinate structure partially or completely removed, and the other turbinate structures were not disturbed.

FINAL EXAMINATION

Following the surgical procedure, a minimum period of six months was allowed to elapse before the patient was examined in order that the effect on the antrum and the adjacent structures might be accurately determined. The patient's history of any nasal disturbances experienced during the interim was taken. The naris and the nasopharynx were examined for discharge, discoloration, thickening of the tissues and growth of lymphoid tissue.

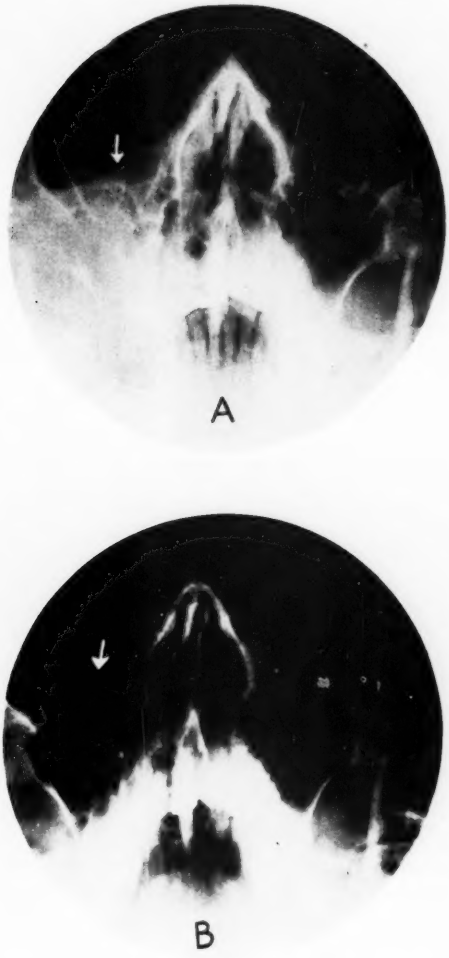


Fig. 14 (case 11).—*A*, preoperative roentgenogram showing left maxillary sinus markedly cloudy. The sinus was treated by the middle meatus window operation. *B*, roentgenogram made nine months after operation. The left antrum appears normal.

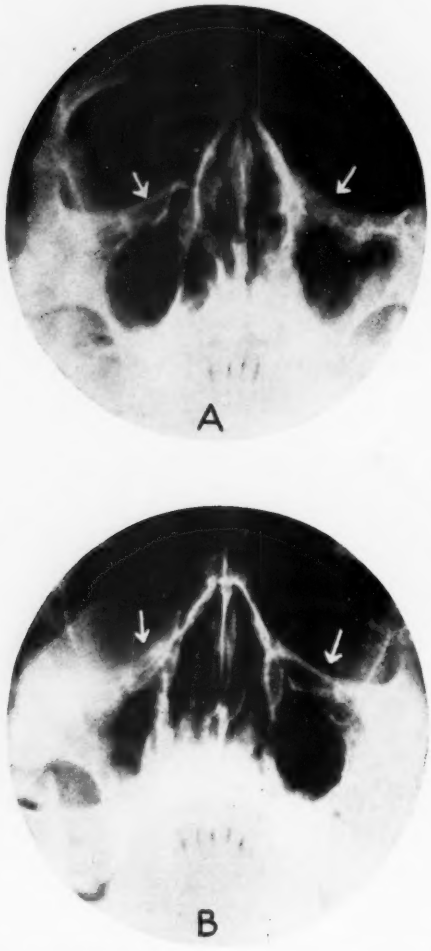


Fig. 15 (cases 12 and 13).—*A*, preoperative roentgenogram showing increased density of both antrums. Each antrum was treated by the middle meatus window operation. *B*, roentgenogram made seven months after operation. It shows the antrums cloudy. No improvement is noted in the left antrum, much improvement in the right.

The inferior meatus was anesthetized with butacaine sulfate U.S.P. (butyn sulfate®) care being taken that none of the solution reached any other portion of the naris.

In introducing the trocar and cannula into the antrum an attempt was made to place them so that the distal end would lie just beneath the operative window.

Through the cannula a nasopharyngoscope was passed. It was possible to obtain a satisfactory view of the lower edge of the window, of the lining membrane just below the window and of the lower edges of the posterior and anterior portion of the window in each case. In a few cases the superior part of the window was visible, but in most instances the distance from the nasopharyngoscope was too great for a detailed examination.

In all the cases except nos. 1 and 3, the lining membrane was normal below the window, and neither granulation tissue nor scarring nor abscess formation was noted in any visible area of any of the antrums. The foregoing statement was true of the case in which the window had closed.

In cases 1 and 3, though the lining membrane appeared normal elsewhere, some thickening was discerned just below the window. This thickening was not due to granulation or fibrous tissue but apparently was due to edema.

The ideal postoperative examination would have consisted of opening each antrum through the canine fossa and taking a section of tissue from just below the antral window for biopsy This was impossible; hence, with this limitation, one utilized the nasopharyngoscope.

Immediately after the aforementioned examination and with the cannula still in place, 0.2 cc. of india ink was injected into the antrum. When the cannula was removed, the inferior meatus was tightly packed with cotton to prevent any possible leakage. The patient's head was kept erect and the middle meatus observed in order to ascertain when and if the india ink appeared by ciliary activity in the normal manner.

Subsequent to this observation and after anesthesia had been produced, the window was examined with a probe for patency and any abnormality of the surrounding tissue. The antrum was then irrigated with isotonic sodium chloride solution, after which the middle meatus was examined with a nasopharyngoscope. A roentgen examination was made.[22] If the interpretation of the roentgenograms was unsatisfactory, iodized poppyseed oil 40 per cent was injected into the antrum and additional roentgenograms were made.

As the time required to eliminate iodized oil from an antrum is such a variable factor, as shown in many cases not connected with this experimental work, it was decided not to confuse the final results by routinely injecting iodized oil and observing by roentgen examinations whether it was eliminated from the antrum both by ciliary action and by gravity.

Table 2 gives a detailed report of each case from the first through the final examination.

PATHOLOGIST'S REPORT MADE ON MICROSCOPIC EXAMINATION OF TISSUE REMOVED FROM THE MIDDLE MEATUS WHILE THE ANTRAL WINDOW WAS BEING MADE

CASE 1 (J. D.).—There are superficial areas of necrosis with exudative and acute purulent inflammation. This inflammation is present on a surface lined

22. The roentgenograms taken in case 1 are not shown because it was impossible to obtain the first plates from the roentgenologist. It would be unfair and noninformative to show only the end results.

TABLE 2.—*Summary of Data on Twelve Patients in Whom an Antral Window*

Case	Patient	Race	Sex	Age	Diagnosis	History	Nasal Discharge	Gross Pathologic Condition of Nasal Mucous Membrane
1	J. D.	White	M	40	Chronic right maxillary sinusitis	Pain over right cheek for 1 wk.; many previous attacks	Purulent	Congestion
2	O. M. B.	White	F	40	Bilateral chronic maxillary sinusitis	Pain on right side of face; nasal blockage, discharge 1 yr.	Purulent	Marked congestion
3	N. G.	White	F	23	Subacute left maxillary sinusitis	Severe pain over right cheek 2 days, discharge; previous attacks	Purulent	Marked congestion
4	C. G. B.	White	M	59	Chronic pansinusitis	Nasal blockage, headaches and discharge many years	Mucoserous	Congestion; polypi in right naris
5	A. L. N.	White	F	14	Complete bony occlusion of post. choanae; chronic right ethmoid and maxillary sinusitis	Complete nasal blockage, headaches and discharge since infancy	Mucopurulent	Congestion
6	L. W.	White	F	34	Chronic right max. sinusitis	Blockage of ears, nasal discharge, frequency of coryza 5 yr.	Purulent	Congestion
7	A. J. W.	White	F	16	Subacute pansinusitis	Headaches, nasal blockage, pain over right cheek 6 mo.	Purulent	Definite congestion
8	P. P.*	White	F	35	Bilateral chronic max. sinusitis	Headaches, nasal blockage, frequency of coryza 2 yr.	No discharge	Slight congestion
9	F. P.*	White	F	35	Bilateral chronic maxillary sinusitis	Headaches, nasal blockage, frequent coryza 2 yr.	No discharge	Moderate congestion
10	N. C.	White	M	21	Bilateral subacute maxillary sinusitis	Nasal discharge with blockage, headaches 1 mo.	Purulent	Congestion and edema
11	E. L. T.	White	F	29	Left maxillary and ethmoid sinusitis	Attacks for 1 yr. with pain, nasal discharge and blockage	Purulent	Congestion
12	V. M. B.*	White	F	44	Bilateral chronic maxillary and ethmoid sinusitis	Attacks for 2 yr. with headaches, nasal discharge and blockage	Purulent	Marked congestion
13	V. M. B.*	White	F	44	Bilateral chronic maxillary and ethmoid sinusitis	Attacks for 2 yr. with headaches, nasal discharge and blockage	Purulent	Marked congestion

* Patients 8 and 9 are the same person; patients 12 and 13 are the same person; i. e., a patient operated on bilaterally is reported as 2 patients.

Was Made in the Middle Meatus Without Additional Surgical Procedures

Gross Pathologic Condition of Nasopharynx	Interpretation of Roentgenogram	Size and Shape of Antrum	Naris	Position of Middle Turbinate Bone	Position of Nasal Septum	Condition of Middle Meatus as Viewed with Nasopharyngoscope	Clinical Evidence of Nasal Allergy
Moderate congestion; lymphoid nodules swollen	Right maxillary sinusitis	Large and round type	Crowded	Close to lateral wall	Midline	Edema and congestion; ostium not seen	None
Congestion; purulent secretion	Bilateral maxillary and rt. sphenoid sinusitis	Small, triangular	Crowded	Ample room for drainage	Deviated to the left	Thickening and congestion of mucous membrane; ostium not seen	None
Small mass of adenoid tissue; congestion	Left maxillary sinusitis	Large and round	Open	Adjacent to lateral wall	Deviated to the left	Pus seen coming from ostium, edema	None
Lymphoid nodules swollen; congestion and discharge	Bilateral ethmoid and maxillary sinusitis	Large and triangular	Crowded	Adjacent to lateral wall	Markedly deviated to the right	Little congestion, some edema; small polyp seen in ostium	Polypi
Dry and pale; no lymphoid nodules noted	Marked cloudiness of right maxillary sinus	Large and square	Very crowded	Adjacent to lateral wall	Midline	Swelling and congestion; ostium very small	None
Lymphoid nodules swollen; mucous membrane thickened and congested	Bilateral cloudiness of antrums	Small and triangular	Open	Normal	Midline	Swelling and congestion; infundibulum a tiny groove; ostium not seen	None
Adenoid tissue; mucous membrane thickened and congested	Maxillary sinuses cloudy; ethmoid sinuses slightly cloudy; sphenoid sinus suggests involvement	Medium size, round triangular	Crowded	Adjacent to lateral wall	Deviated to the left	Ostium pinpoint in size; much congestion	None
Small mass of adenoid tissue	Maxillary sinuses cloudy	Large and square	Crowded	Room for drainage	Deviated bilaterally	No congestion; ostium noted	None
Small mass of adenoid tissue	Maxillary sinuses cloudy	Large and square	Open	Room for drainage	Deviated bilaterally	Moderate congestion; ostium not seen	None
Lymphoid nodules swollen; congestion	Maxillary and ethmoid sinuses cloudy	Large and triangular	Open	Adjacent to lateral wall	Deviated to the left	Pus coming from ostium; swelling and congestion	None
Adenoid tissue; lymphoid nodules swollen and congested	Left maxillary and both ethmoid sinuses cloudy	Small and triangular	Crowded	Adjacent to lateral wall	Deviated to the left	Pus present; small polyp; congestion; ostium not seen	None
Lymphoid nodules swollen; congestion	Maxillary and ethmoid sinuses cloudy bilaterally	Medium size, round	Open	Room for drainage	Midline	Pus present; congestion	None
Lymphoid nodules swollen; congestion	Maxillary sinuses quite cloudy; ethmoid sinuses cloudy	Medium size, round	Open	Room for drainage	Midline	Pus present; congestion	None

No eosinophilic leukocytes were found in the smears of any of the cases.

TABLE 2.—*Summary of Data on Twelve Patients in Whom an Antral Window Was*

Case	Patient	Result of Antral Irrigation *	Bacteria Isolated from Antrum	Interpretation of Roentgenograms of Antrum Made After Injection of Iodized Oil †	Date and Side of Middle Meatal Resection	Interim (Months) Between Operation and Final Examination	History of Nasal Condition Since Operation	Nasal Discharge	Appearance of Nasal Mucous Membrane
1	J. D.....	Pus	Staph. aureus	.....	12/ 4/44 Right	11	Has had only slight discharge; no other complaints	Mucoid	Slightly congested
2	O. M. B.....	Pus	Str. hemolyticus	No filling defect of either antrum	10/16/45 Right	6½	Drainage and headaches at times	None	Normal
3	N. G.....	Pus	Pneumococcus	.....	4/ 5/45 Left	6½	Headaches occasionally; condition improved	Mucoid	Moderately congested
4	C. G. B.....	Return clear	Str. hemolyticus	Large filling defect of right antrum	12/ 7/45 Right	8	Occasional attacks of sinusitis; condition much improved	None	Congested
5	A. L. N.....	Pus	Str. hemolyticus	.....	5/ 7/45 Right	7	No complaints	None	Slightly congested
6	L. W.....	Pus	Staph. albus and Friedländer's bacillus	No filling defect	11/ 2/44 Right	10	No complaints	None	Normal
7	A. J. W.....	Return clear	Staph. aureus	Moderate-sized filling defect	3/ 5/45 Right	7	Only occasional nasal blockage	None	Normal
8	F. P.....	Return clear	Str. hemolyticus	.....	10/25/45 Right	6	Occasional headache	None	Normal
9	F. P.§.....	Pus	Str. hemolyticus and pneumococcus	.....	10/ 5/45 Left	6	Occasional headache	None	Normal
10	N. C.§.....	Pus	Pneumococcus	Large filling defect	12/ 4/44 Right	9	No complaints	None	Slightly congested
11	E. E. T.....	Pus	Staph. hemolyticus	.....	12/ 4/44 Left	9	No complaints	None	Normal
12	V. M. B.§.....	Pus	Streptococcus, unidentified	Moderate filling defect	3/ 4/46 Right	7	No complaints	None	Normal
13	V. M. B.§.....	Pus	Streptococcus, unidentified	Moderate filling defect	3/ 4/46 Left	7	No complaints	None	Normal

* This and the following columns are to be considered as continuations of the first half of the table of the preceding pages. The case numbers have been repeated for the convenience of the reader.

† Roentgenograms were made after injection of iodized oil only in cases in which additional information was desired.

§ Patients 8 and 9 are the same person; patients 12 and 13 are the same person; i. e., a patient operated on bilaterally is reported as 2 patients.

Made in the Middle Meatus Without Additional Surgical Procedures—Continued

Appearance of Middle Meatus as Viewed with Naso-pharyngoscope	Appearance of Nasopharynx	Appearance of Lining Membrane of Antrum as Viewed with Nasopharyngoscope	Interim (Minutes) Between Introduction and Reappearance of India Ink	Patency of Window	Condition of Middle Meatus as Examined with Probe	Result of Antral Irrigation	Interpretation of Roentgenogram
Slightly congested; margins of window healed	Few swollen lymphoid nodules present	Moderately congested; some thickening of lining membrane just inferior to window	33	No contraction	Normal	Return clear	Right antrum moderately cloudy
Not congested; margins of window healed	Normal	Normal	21	No contraction	Normal	Return clear	Right antrum slightly cloudy
Somewhat congested; margins of window healed	Congested	Lower edge of window thickened; this area congested	24	No contraction	Normal	Return clear	Left antrum slightly cloudy
Somewhat congested; window closed; ostium not seen	Congested	Normal; no window seen	29	Closed	Normal	Return clear‡	Right antrum moderately cloudy
Normal; margins of wound healed	Normal	Normal	32	No contraction	Normal	Return clear	Right antrum slightly cloudy
Congested; margins of wound healed	Normal	Normal but congested	31	No contraction	Normal	Return clear	Right antrum normal
Normal; margins of wound healed	Normal	Normal	22	No contraction	Normal	Return clear	Right antrum normal
Slightly congested; margins of window healed	Slightly congested	Normal	19	No contraction	Normal	Return clear	Right antrum normal
Normal; margins of wound healed	Slightly congested	Normal	21	No contraction	Normal	Return clear	Left antrum normal
Somewhat congested; margins of wounds healed	Somewhat congested; lymphoid nodules noted	Slightly congested	6	No contraction	Normal	Return clear	Right antrum normal
Normal; margins of wounds healed	Normal	Normal	62	No contraction	Normal	Return clear	Left antrum normal
Normal; margins of window healed	Normal	Normal	28	No contraction	Normal	Return clear	Lining membrane thickened
Normal; margins of window healed	Normal	Normal	29	No contraction	Normal	Return clear	Lining membrane thickened

‡ In case 4 the middle meatal approach was used in irrigating the antrum at the time of the final examination, even though the window had closed. The tissues had the same characteristics as a normal pars membranacea.

Roentgenogram made after injection of iodized oil showed a small filling defect inferiorly in case 8.

by intermediate squamous epithelium. There is chronic inflammation in the mucous glands. A small fragment of bone is attached to the base. This contains loose connective tissue in the medulla, and the cortex seems to be partially decalcified.

Case 2 (Mrs. O. M. B.).—There is a small bit of columnar epithelium with much acute and chronic inflammatory exudate.

Case 3 (Mrs. N. G.).—Sections show a mucous membrane lined by columnar cells. Beneath this there is chronic inflammation, also a few spicules of bone.

Case 4 (C. G. B.).—There is one single fragment of bone. The other specimen consists of a mucous membrane lined by columnar cells and containing mucous glands. No inflammation is seen.

Case 5 (Miss A. L. N.).—The site of this tissue cannot be determined with certainty. The large number of mucous glands underlying the covering columnar cells suggests that the tissue came from the nose of the nasopharynx. It shows acute and chronic nonspecific inflammation.

Case 6 (Mrs. L. W.).—There is a small bit of columnar epithelium with a chronic inflammatory exudate.

Case 7 (Miss A. J. W.).—The specimens consist of serous glands covered by columnar epithelium. There is slight chronic inflammation.

Case 8 (Mrs. F. P., right antrum).—Although there is some edema as well as some lymphocytic and plasma cell infiltration, the most interesting feature is the presence of hemosiderin-laden phagocytes. The mucosa in itself is not remarkable.

Case 9 (Mrs. F. P., left antrum).—There is minimal chronic submucous inflammation. The most interesting feature is ectopic calcification of the stroma. Sometimes these foci are concentrically laminated like psammoma bodies.

Case 10 (N. C.).—A tiny mass of mucous glands partly covered by columnar epithelium shows hemorrhage, edema and acute inflammation.

Case 11 (E. E. T.).—A narrow strip of mucous membrane is covered on two sides by pseudostratified columnar epithelium. It contains many mucous glands, a few of which are cystic. There is minimal chronic inflammation.

Case 12 (V. M. B., right antrum).—Sections show mucous membrane lined by columnar epithelium. Some areas of necrosis are noted. Chronic inflammation is seen.

Case 13 (V. M. B., left antrum).—The section shows polypoid masses of tissue covered by pseudostratified columnar epithelium of varying thickness and with a loose, almost myxomatous stroma. The stroma is heavily infiltrated by eosinophils, plasma cells and lymphocytes.

SUMMARY AID COMMENT

This series is too small for one to be able to deduct any definite conclusions.

Many men who oppose making a window in the middle meatus without radical maxillary sinusotomy make such an opening when doing radical antrotomy or radical antrotomy and ethmoid exenteration, though they consider it unnecessary for complete ethmoidectomy. In some instances the opening is made through both the inferior and the middle meatus. This apparently paradoxic attitude has not been explained satisfactorily.

One patient, after the injection of india ink, had acute pain for thirty minutes. He had no other symptoms. Some tenderness was present over the antrum for three days. Some of the ink may have penetrated the soft tissues, although the ink was observed in the middle meatus after the injection.

It was difficult, after india ink had been injected into the antrum, to observe the fine streaks in the middle meatus. Various types of lights both with and without magnification were tried but were of little aid. A fine probe with cotton wrapped around the tip was touched to the middle meatus from time to time and then observed for deposits of india ink. This method was satisfactory.

Neither abscess formation nor infection nor webs of scar tissue occurred within the antrum in those cases in which the antral ostium had been removed or traumatized. Ciliary action continued as normal after the experimental surgical treatment.

Of the 32 patients who were operated on for chronic or subacute maxillary sinusitis, only 13 returned for a final examination. The other 19 stated that they had had no symptoms and felt "too good to visit a physician." Of the 13 patients on whom a final examination was made, 12 had had no infection of the upper respiratory tract. Two complained of occasional nasal blockage. Four had occasional headaches. Eleven stated that the amount of nasal discharge was apparently normal, while 2 felt that it was more than normal. Of these 13 patients, 7 felt that they were cured; 5, though they had occasional minor nasal complaints, felt that these were of a minor nature, and the one who continued to have occasional infections of the upper respiratory tract thought that he was improved.

A former member of the rhinologic staff of Washington University has been helpful in the preparation of this paper. His name has been omitted at his request, as he no longer is specializing in rhinology.

Members of the American Laryngological, Rhinological and Otological Society, Inc., gave encouragement and valuable assistance.

1022-1028 Bennie-Dillon Building.

SYMPTOMATIC ELONGATED STYLOID PROCESS

Report of Two Cases of Styloid Process–Carotid Artery Syndrome with Operation

WATT W. EAGLE, M.D.
DURHAM, N. C.

SOME of the obscure, as well as common, pharyngeal pains, painful deglutition and referred otalgia may be traced to an elongated styloid process.[1] It is of interest that these symptoms are usually found only after tonsillectomy. I now hope to establish that the elongated styloid process may also cause facial pain and headache, even when tonsillectomy has not been performed, owing to impingement of the process on a carotid artery. Thus, there exist two distinct syndromes referable to the styloid process; these syndromes present groups of symptoms which differ in their anatomic locations.

The classic, and commoner, syndrome usually relates all symptoms to the pharynx and the ear, but occasionally an atypical group of symptoms may be referred to the hypopharynx and the upper part of the esophagus.[1f] The second syndrome, which I shall designate as the styloid process–carotid artery syndrome, presents symptoms related to the pattern of distribution of either the internal or the external carotid artery.

HISTORICAL REVIEW

The historical background of the elongated styloid process is interesting, but it suffices now merely to recall that the elongated process occurs in approximately 4 per cent of persons, but that only a few of these persons have symptoms. It is of further historical significance that the elongated styloid process had been of anatomic rather than clinical interest until the recent past. The elongated styloid process may be hereditary, as my associates and I have found 3 siblings, the

From the Division of Otolaryngology, Department of Surgery, Duke University Hospital and School of Medicine.

Read before the Section of Otolaryngology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 23, 1948.

1. (*a*) Stirling, A. W.: On Bony Growths Invading the Tonsil, J. A. M. A. **27**:734 (Oct. 3) 1896. (*b*) Thigpen, C. A.: Styloid process, Tr. Am. Laryng., Rhin. & Otol. Soc. **38**:408, 1932. (*c*) Eagle, W. W.: Elongated Styloid Process, Arch. Otolaryng. **25**:584 (May) 1937. (*d*) Fritz, M.: Elongated Styloid Process, ibid. **31**:911 (June) 1940. (*e*) Loeser, L. H., and Cardwell, E. P.: Elongated Styloid Process, ibid. **36**:198 (Aug.) 1942. (*f*) Eagle, W. W.: Elongated Styloid Process: Further Observations and a New Syndrome, ibid. **47**:630 (May) 1948.

only siblings of the family, all of whom had symptoms immediately after tonsillectomy. The elongated process may be found in young adults, but is oftener observed in patients 30 years or older. In 1 case we found an elongated process during tonsillectomy in a child aged 14.

At the turn of the century, keen clinical observations caused the elongated process to be considered the origin of a definite clinical entity. The normal styloid process is approximately 2.5 cm. (1 inch) in length, and any process beyond this length may be considered elongated. It is conceivable that a styloid process of normal length may be symptomatic when a deviation in the axis at the tip of the process occurs, impinging against either the external or the internal carotid artery and causing disturbance in the circulation in the artery, as well as stimulation of the sympathetic nerve fibers in the arterial walls. The tip of the process normally lies between the internal and external carotid artery, and the process is usually fairly straight, with the entire shaft pointing a little medially. There are three small muscles and two ligaments attached to the styloid process, but the function of the muscles is not important or very well known. Certainly, the muscles can be of no great significance, because after their resection in the operation of shortening the styloid process the patient notices no abnormality in the functions of swallowing or speech.

CLASSIC SYNDROME

The classic syndrome produces a typical sequence of symptoms, which almost constantly occur immediately after tonsillectomy. The patient complains of pain in the throat throughout the entire convalescence and then continues to complain of a sore throat during the ensuing years. Patients actually believe that the throat never healed after the tonsillectomy. They sometimes have the sensation that a foreign body, such as cotton, spicules of wood, or even metallic substances, is lodged in the throat. There may be difficulty in deglutition, and considerable pain may occur during the act. Frequently, pains are referred to the ear on the side of the elongated styloid process. The difficulty in swallowing may involve not only the pharyngeal muscles, but also the constrictor muscles of the upper part of the esophagus and the hypopharynx. The pharyngeal symptoms are composed of nagging and dull, aching pains, which become much worse during the act of deglutition; in addition, there may be a sharp pain in the pharynx. The pain is in no way comparable to the momentary, lancinating pains, of extremely severe character, that occur in cases of glossopharyngeal neuralgia. The pharyngeal pains are due to the stretching or fibrosis that occurs during the post-tonsillectomy healing in the sensory nerve endings of the fifth, seventh, ninth and tenth cranial nerves, all of

whose branches supply the involved area. It is rare for the patient to have symptoms of the classic type when the tonsils have not been removed.

In tonsillectomies, especially in instances in which a snare or guillotine is used, the surgeon has undoubtedly encountered the elongated styloid process, and this abnormality not only caused difficulty during the operation but prevented the total removal of the tonsils, with subsequent bleeding. With the dissection method of tonsillectomy the elongated styloid process will also be encountered, but it will cause a minimal handicap to the thorough removal of the tonsil. Should the elongation of the styloid process be bilateral, the symptoms may be bilateral. Many patients, however, who have bilateral elongation of the processes also have no symptoms.

STYLOID PROCESS–CAROTID ARTERY SYNDROME

The symptoms of this syndrome may occur whether the tonsils have been removed or not. Any styloid process, especially the elongated one, whose tip deviates medially or laterally may cause considerable pressure on the internal or the external carotid artery, not only impairing the function of the vessel by diminishing the caliber, but also causing most pronounced symptoms by irritation of the sympathetic nerve fibers, which form a rich supply to the walls of the carotid artery. There is oftenest a variation in the location of the bifurcation of the common carotid artery, and, since near the bifurcation the external carotid artery may lie more medial than the internal cartoid artery, confusion may exist in interpretation of how the internal carotid artery could be affected when the position in the neck is supposedly that of the external carotid artery.

When the elongated styloid process impinges on the carotid artery considerable tenderness may be elicited locally on palpation over the artery. Frequently, a tender artery is mistaken for tender cervical lymph nodes when the artery is superficial. Lymph nodes overlying the artery are always tender. Carotodynia, as described by Fay, could be due to an elongated styloid process. In some instances the elongated process may actually be palpated just posterior to the mandible, or as it extends beneath the lower edge of the mandible, especially in those cases in which there is little subcutaneous tissue or the process is extremely elongated. The pinching of the carotid artery will cause distribution of pain in the pattern of distribution of that artery. This is of diagnostic significance, because the areas of the head supplied by the two carotid arteries are entirely different. Persons in whom the internal carotid artery is involved will complain of parietal headaches and head pains throughout the distribution of the ophthalmic artery, which is the normal area of distribution of the internal carotid artery.

Little or no pain will occur below the level of the eye. In cases in which the external carotid artery is affected the pain will be referred to the region below the level of the eye, in the region normally supplied by the numerous branches of the external carotid artery.

It is quite probable that in many cases in which pain and headache occur on one or both sides of the head an elongated process may be the cause of the symptoms. This is a probability to be considered in cases in which a diagnosis has otherwise been obscure, difficult or even impossible. Some patients are undoubtedly treated for histamine sensitivity, migraine or vascular headaches when their symptoms are really due to pressure on a carotid artery by an elongated styloid process which deviates at the tip. It is well to remember that in the styloid process–carotid artery syndrome tonsillectomy does not necessarily precede the onset of symptoms.

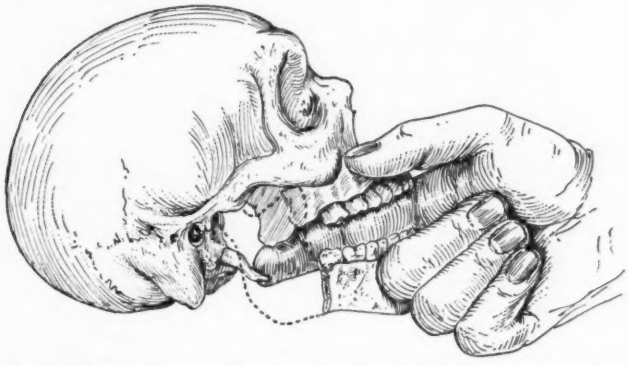


Fig. 1.—Diagram demonstrating the ease with which the palpating finger locates the elongated styloid process.

DIAGNOSIS

The diagnosis of an elongated styloid process, or even one that is not elongated but is symptomatic, should not be difficult. In cases of the classic syndrome the history of the symptoms following a tonsillectomy is always most suggestive, and the palpating finger provides evidence for definite conclusions. Roentgenograms give still further confirmation. To palpate the elongated process, the curved index finger is placed in the open mouth—not too widely open—and the tip of the finger is inserted into the tonsillar fossa (fig. 1). It is most important that the palpating finger not be allowed to glide over the base of the tongue, which sets up a severe gag reflex, for palpation is a fairly easy procedure to perform if the tip of the finger is carefully placed in the tonsillar fossa. If a firm resistance is met by the palpating finger in the

tonsillar fossa, it can only be an elongated styloid process that is felt. A styloid process of normal length is never palpable. The presenting portion which is palpated is most likely to be the tip of the process, or it may be a portion of the calcified stylohyoid ligament. If the patient's symptoms are due to the elongated process, he will wince from pain as the palpation is performed; he will state that the palpation produced exactly the same symptoms as those he usually experiences, though perhaps of severer intensity. The diagnosis is then quite clear, because the elongated process is the only possible firm structure which can be palpated beneath the tonsillar fossa and be painful on palpation. In order to ascertain the exact length of the styloid process, lateral roentgenograms are necessary. The lateral views are also valuable at the time of the surgical shortening in determining the length of the segment of the elongated process which is to be resected.

If the patient exhibits symptoms of tenderness and compression of the carotid artery, it may be necessary to palpate through a tonsil, a procedure which is not very satisfactory if the tonsil is large and thick. Even so, much tenderness will be elicited on palpation through the tonsil. If the tonsils have been removed, the elongated process is easily demonstrated by palpation. With one palpating finger in the tonsillar fossa and another placed externally on the neck, extreme pain may be elicited. It is necessary in all cases in which the styloid process is suspected of causing symptoms referable to the carotid artery to have posteroanterior roentgenograms, because this view will demonstrate any deviation of the process in the shaft itself and, of the greatest importance, at its tip. The lateral roentgenogram is again utilized in determining the total length of the process and the length of the segment to be resected. The deviation at the tip of the process may project either medially or laterally, a position which may or may not give some indication as to whether the internal or the external carotid artery is impinged on. The distribution of the pain denotes which artery is involved. By injection of a radiopaque substance into the blood stream of the common carotid artery, it should be easy in doubtful cases to demonstrate on the roentgenogram the exact artery involved and how tightly embedded the process may be against the arterial wall. The latter diagnostic procedure has not been necessary or advisable in the cases under our observation in which the presence of the styloid process–carotid artery syndrome was suspected.

DIFFERENTIAL DIAGNOSIS

There should be little difficulty in differentiating the typical, so-called classic, syndrome. The tonsils will have been removed, and the symptoms will have followed the operation. The palpating finger in the tonsillar fossa is the differentiating factor. There may be some difficulty in

eliminating the possibility of sphenopalatine ganglion neuralgia or temporomandibular joint syndrome or the role of an unerupted and impacted third molar. The laboratory studies should to some extent clear these various problems. Cocainization of the sphenopalatine ganglion would certainly not eliminate the symptoms in the pharynx with referred pain to the ear due to an elongated styloid process. The patient with the temporomandibular joint syndrome probably has a history of partial or total molar extraction just prior to the onset of symptoms, or he will admit sleeping on his face with his chin pushed by his hand or pillow to one side—the side on which he is having pain. The presence of an unerupted and impacted third molar can be diagnosed easily by observing the absence of that molar, with no history of extraction, and roentgenographic demonstration of the impactions. Glossopharyngeal neuralgia is easily distinguished by the sudden, lancinating pain in the pharynx of short duration, usually brought on by the stimulation afforded by hot or cold foods, liquids or even the movements of the tongue in the pharynx.

TREATMENT

There is only one satisfactory and sure method of alleviating the symptoms due to an abnormal styloid process: the surgical shortening of the elongated process or the surgical removal of a tip of a process of normal length that may be impinging on a carotid artery.

The intraoral surgical route is preferred and is, indeed, the simpler route of approach. The external approach [1e] necessitates an undesirable external scar on the neck and along the lower border of the mandible. The intraoral route requires no different setup for anesthesia and approach than the exposure for tonsillectomy. The Davis-Crowe mouth gag is preferably used, with light anesthesia induced with ether passed through the tongue blade to the area just above the glottis. The light anesthesia insures that the cough reflex, which prevents the aspiration of any blood or secretions, is never abolished. Suction is also used throughout the operation. The foot of the operating table is elevated, which further prevents any aspiration. As the operation is completed, the patient is usually able to converse with the operator after the mouth gag has been removed, though not necessarily in a coherent manner. The need for nursing care after an operation with light anesthesia is therefore reduced to a minimum, since the patient returns to the ward rather well recovered from the anesthesia. (The nursing problem in all hospitals today is to be considered seriously.)

The operation itself requires the longitudinal separation of the mucosa at the point of palpation of the process in the tonsillar fossa, with the immediate separation of the muscles beneath the mucosa. This opening is best made with the right-angled tonsillar scissors opened

wide. The palpating finger is then inserted into the open wound, and the denuded tip of the styloid process is immediately recognized. The palpating finger is used to dissect free all the muscle attachments on the medial and anterior portions of the styloid process, and then a curved septal elevator is used to dissect the muscles from the lateral and posterior insertions on the styloid process. The stylohyoid ligament has, in the meantime, presented itself clearly and is then resected. If in a case of the styloid process–carotid artery syndrome the tonsils are present, the aforementioned procedure is carried out after the tonsillectomy, the tonsillectomy being required for access to the styloid

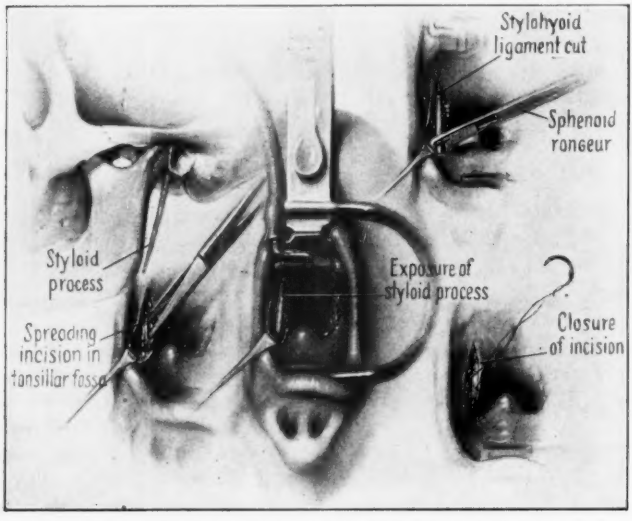


Fig. 2.—Stages in the technic involved in the intraoral shortening operation of the elongated styloid process.

process. It is a pleasure to shorten a styloid process in a fresh tonsillectomy wound, since there is no scar tissue to deal with (fig. 2).

The lateral roentgenograms have already demonstrated the entire length of the styloid process, and since one wishes to leave a stump no longer than 2.5 cm., it is easy to determine how much of the elongated process is to be resected. A clamp should grasp the distal end of the process as the segment is broken free by a Hajek sphenoid forceps; otherwise, any muscles still attached may retract the resected portion into the muscular field, and it is then very difficult to locate the freed segment. There is no bleeding in the average case, since no blood vessels are actually severed, and the approach is made entirely by

longitudinal dissection in the tonsillar fossa and muscles. Should bleeding occur, it is easily controlled by O surgical gut sutures. Infections of the parapharyngeal space are avoided by the insertion of sulfanilamide powder into the wound before closure. The sulfanilamide powder is preferred to the powder of any other sulfonamide drug because of its universal action on streptococci, staphylococci, fusospirochetal and anaerobic organisms. The muscles and mucosa are closed with plain O surgical gut sutures.

The immediate postoperative period is calm and not too painful. There is much less pharyngeal discomfort after operation on the styloid process than after a tonsillectomy, since in the operation on the styloid process the wound is closed tightly, thereby preventing secondary infection or a granulating open wound. The patient is able to leave the hospital on the third or fourth postoperative day. Occasionally, swelling

Fig. 3 (case 1).—The ram's horn type of elongated styloid process; in this case the tip fitted tightly against the external carotid artery.

may occur in the neck, which I believe is due mainly to sensitivity to the sulfonamide powders left in the wound, for little swelling occurs in the pharynx itself.

RESULTS

The operation for surgical shortening of the styloid process has in our experience always produced excellent results. Other procedures short of the actual shortening of the process, such as fracturing of the process by the palpating finger, have only partially alleviated the symptoms, and the results cannot compare at all with the results of the surgical resection.

REPORT OF CASES

Case 1. *External Carotid Artery Syndrome.*—Mrs. R. S., aged 67, reported on previously,[1f] was our first operative patient who had symptoms suggestive of an elongated styloid process, with impairment of function of the external carotid artery

and pain along the distribution of the artery on the left side of the head. The operation for shortening the process was performed in August 1946. The tip of the process was tightly wedged against the left external carotid artery, causing quite a constriction of the lumen, as well as considerable compression of the sympathetic nerves in the arterial walls. It was resected. The postoperative convalescence was quiet, and the results were excellent with relief of pain immediately after the operation (fig. 3).

CASE 2. *Internal Carotid Artery Syndrome.*—W. J. P., a man aged 39, was first seen on Feb. 10, 1948. He gave a history of severe pain in the left frontal area and vertex of five years' duration. The pain usually occurred every two to four days and lasted two to four days. All teeth had been extracted and replaced with plates, and there was no suggestion of the temporomandibular joint syndrome.

Fig. 4 (case 2).—Retouched posteroanterior roentgenogram, demonstrating the medially deviated tips of the elongated styloid processes; in this case the right styloid process was longer than the left but was asymptomatic; the left one was symptomatic only because it was tightly embedded on the left internal carotid artery.

The tonsils and adenoids had been removed, and he had had surgical treatment of the intranasal sinuses many years previously. His hearing and vision had not been impaired, although there was occasional tinnitus in the left ear. The findings on physical examination were normal in every respect except for the bilateral elongated styloid process. Laboratory studies, including serologic tests of the blood revealed no abnormality. The styloid process was definitely elongated bilaterally, the right being a little longer than the left and each being more than 5 cm. in length. Each process showed a medial deviation just above the tip. Since the patient's headache and head pains coincided with the area of distribution of the left internal carotid artery, it was thought that his symptoms were due

to impingement of the elongated styloid process on the vessel and the sympathetic nerves in the vessel walls, with disturbance of their function. On Feb. 12, 1948 the patient had bilateral shortening of the elongated styloid process, although only the left process was considered symptomatic. A total of 3.5 cm. was removed on each side. He was seen in a follow-up examination on May 15, 1948 and was found to be completely free of the headaches and head pains. He has now pain on the left side of the pharynx, at night only; this is thought to be due to formation of scar tissue in that area, and we feel certain that pain will eventually subside (fig. 4).

COMMENT

Further knowledge and experience have been attained in dealing with the symptomatic elongated styloid process. The classic syndrome pains in the pharynx and ear due to an elongated styloid process is now more frequently recognized and successfully treated than in previous years. In very recent years a syndrome has been recognized in which tenderness of a carotid artery on palpation is associated with an elongated styloid process and coexistent headaches or head pains in the pattern suggestive of irritation of a carotid artery. Previously these symptoms had evaded diagnosis, but it is now recognized that they represent the styloid process–carotid artery syndrome. Therefore, it is our impression that some headaches are caused by an elongated styloid process and that these headaches occur when a tip, or even the shaft, of a styloid process projects either medially or laterally to cause pressure on either the external or the internal carotid artery. The symptoms, when present, will invariably occur in the pattern of distribution of the internal or the external carotid artery. The syndrome has been easily confused with the vascular or histamine type of headache and pain. The possibility of this syndrome should certainly be considered, or at least eliminated, in all cases in which the distribution of pain lies in the pattern of distribution of either of the carotid arteries. Roentgenograms should certainly be utilized to determine the length of the styloid process and the status of the tip of the process in its relation to the carotid arteries, even in cases in which tonsillectomy has not been performed. It is inexcusable not to use the palpating finger in the tonsillar fossa for diagnostic purposes; this palpation should be done routinely on all patients complaining of headaches or pains suggestive of a dysfunction of the carotid artery. Arterial injections of a radiopaque material should be resorted to when there is not a roentgenologically visible or a palpably elongated styloid process, or when the presence of an abnormality, such as a deviated tip of a process of normal length, is suspected.

SUMMARY

The symptomatic elongated styloid process produces a characteristic group of symptoms. These symptoms may occur in two distinct groups: (1) the classic syndrome, always occurring after tonsillectomy, with

the symptoms involving the pharynx and hypopharynx, with referred pain to the ear, and (2) the styloid process–carotid artery syndrome, in which symptoms are produced along the distribution of an external carotid artery or an internal carotid artery by impingement on the vessel, affecting the circulation in the vessel and producing irritation of the sympathetic nerves in the arterial sheath. A process of normal length may have a deviated tip producing the symptoms, and tonsillectomy does not necessarily precede the onset of symptoms in the styloid process–carotid artery syndrome.

The symptoms, diagnosis, differential diagnosis, surgical treatment and results of operation are discussed. Two cases of the styloid process–carotid artery syndrome are reported, in both of which operation was performed. In the first case the symptoms related to the external carotid artery, while in the second case symptoms referable to the area of distribution of the internal carotid artery were exhibited. An attempt has been made to demonstrate that the styloid process–carotid artery syndrome may be the disease underlying many of the undiagnosed and obscure head pains and aches which have been treated unsuccessfully, because they were thought to be due to migraine, vascular spasm, histamine sensitivity and similar conditions.

The palpating finger is most useful in reaching a diagnosis, because it will invariably find an elongated styloid process beneath the tonsillar fossa, when it exists. Digital palpation should always be performed in the tonsillar fossa in all cases in which symptoms of pharyngeal or facial pain exist. Roentgenograms are useful for confirmation of the information derived from digital palpation. Posteroanterior roentgenograms are necessary in all cases in which the styloid process–carotid artery syndrome is suspected.

Duke University Hospital.

ABSTRACT OF DISCUSSION

DR. C. M. KOS, Iowa City: While the symptom complex of local and referred pharyngeal pain is neither in part nor in its entirety an unfamiliar one, its various causes are sometimes elusive. It is possible that the thesis on which the styloid process–carotid artery syndrome is based may resolve in part the mystery attached to that group of symptoms currently classified as atypical facial neuralgia. The styloid process may be responsible for an even greater variety of symptoms than is generally admitted. Further discussion of this subject is unwarranted in view of the reported successful results obtained by segmental amputation of the styloid process. With this understanding it is not my intention to dispute the proposition of the symptomatic styloid process or the stylocarotid artery syndrome; I wish, rather, to inquire further into certain aspects of them.

Anyone who searches for the elongated styloid process will find it. In some cases it may be symptomatic; in others, not. In most instances the symptomatic styloid process is observed after tonsillectomy. This evokes the question whether

surgical trauma to the styloid tip when it projects into or presses against the tonsillar fossa may establish osteitis or periosteitis and produce the symptom of pain. Such a possibility could explain the apparent tenderness over the adjacent carotid vessels and the presence of palpably sensitive lymph nodes in that area. If the pharyngeal pains are due, as Dr. Eagle describes, to stretching or fibrosis that occurs during post-tonsillectomy healing in the sensory nerve endings of the fifth, seventh, ninth and tenth cranial nerves, it would be unnecessary to implicate the elongated styloid process except as an incidental finding.

The styloid process is a vestigial structure, according to the opinions of comparative anatomists; hence it is present at birth and undergoes little alteration with respect to other cervical structures during the process of growth. Consequently, when it extends beyond its usual length of 2.5 cm. it should give rise to symptoms long before the age at which it is ordinarily observed to become clinically significant, particularly as it may be related to the designated styloid process–carotid artery syndrome.

The hypothesis is presented that stimulation by pressure of the deviated or elongated styloid process causes distribution of pain over the patterns of the external or the internal carotid artery. However possible this may be, comparison by analogy is difficult. Any such analogy may be evidenced by inducing pressure by palpation, which should produce facial or cephalic pain. Compression by tumors over the carotid artery should have a similar effect. There is little conclusive evidence to show that this is so.

Since the elongated styloid process projects between the normally disposed external and internal carotid arteries, an unusual deviation causing pressure might from time to time produce symptoms similar to any of the three manifestations of the carotid sinus syndrome; no such correlation has been made, and pain is not a part of that clinical entity.

The elastic structures of the neck are exposed to variable alterations in pressure resulting from postural relations of the head and neck to the shoulder girdle. It is conceivable that this influence together with that of the elongated styloid process might cause variations in the intensity of the symptoms in either the classic symptomatic complex or the styloid process–carotid artery syndrome. Such an observation has not been noted here, though the act of deglutition has been mentioned as a source of aggravation of pain.

I consider this subject a provocative one; yet I know from personal association that Dr. Eagle has gathered substantial evidence. His study should excite curiosity and lead to more extensive exploration of the problem.

DR. O. E. VAN ALYEA, Chicago: Dr. Eagle has revived an old entity and presented a new syndrome. An elongated styloid process is a condition known to most otolaryngologists, and the styloid process–carotid artery syndrome is worthy of their consideration. Any help to be gained in determining the cause of vague pains about the face is welcome. Certainly, the pain of many such patients fails to fit into the established clinical classifications and, accordingly, fails to respond to known therapeutic measures. Some of these could well fall into the styloid process–carotid artery category.

The elongated styloid process is an embryonic defect. The styloid bone develops, along with the stapes, the stylohyoid ligament and the anterior horn of the hyoid bone, from the cartilaginous core of the second branchial arch. The length of the styloid process depends on the degree of ossification in the proximal portion of Reichert's cartilage. It is easy to understand how variables may occur, as they do in other bony structures of the body.

Dr. Eagles states that the process is abnormally long in 4 per cent of persons, but that symptoms of pressure are present in only a small percentage of these persons. Some authors state that symptoms are present only in persons who also have calcification of the stylohyoid ligament. I should like to ask Dr. Eagle whether he feels that such calcification is necessary for the production of symptoms of pressure.

Dr. Eagle kindly sent me a copy of his paper a few weeks ago, and since then I have been on the alert for elongated styloid processes. To date, I have not resorted to roentgenographic study but I have palpated the tonsillar fossa of many patients, and I feel that this simple measure could well be adopted in the routine search for the cause of the symptoms described in this paper.

Dr. L. A. Nelson, Dallas, Texas: I believe that the hyoid bone may produce the same symptoms as those described by Dr. Eagle. The hyoid bone has from two to three bursas, or small series of sacs, on the posterior part of its body, and rheumatoid disease of the hyoid bone was reported in *The Journal of the American Medical Association* about fifteen years ago. Exertion of pressure from the tips of the greater cornua to the hyoid bone in cases in which this bone is involved produces pain corresponding to the pain the patient complains of. The pain of this syndrome responds to treatment for rheumatic infections, such as the use of salicylates; this treatment would certainly be much easier to try out than an operative procedure on the styloid process. Usually, a week's medication completely relieves the situation, and relief may continue for some time. However, the condition does recur. The mechanism of its recurrence is best seen in cases in which the tonsils have been removed. The scar formation probably changes the tension on the structure as a whole, particularly on the bursas of the hyoid bone, and makes it subject to easy infection.

The fact that the condition responds to treatment may well be considered.

Dr. Murdock Equen, Atlanta, Ga.: Dr. Eagle's presentation has been most interesting. I should like to present a case illustrating the possibility of trauma of the styloid process during a dental procedure. A woman aged 45 suffered severely after the extraction of an impacted molar on the left side of the upper jaw. The extraction was most difficult and painful, and she stated that during the procedure she jumped around in the dental chair. Phenobarbital U.S.P., codeine and even morphine failed to relieve her pain. Her mouth was opened with a great deal of difficulty, and on palpation a fractured styloid process on the left side was found; this finding was corroborated roentgenographically. The patient was anesthetized, and the left tonsil was removed. This gave adequate access to the styloid process. The fractured styloid process was found and removed, and the patient made an uneventful recovery. It is difficult to see how a dental procedure could possibly result in fracture of the styloid process, but the patient's poor cooperation with the dental surgeon, no doubt, accounted for the resulting trauma.

Dr. Watt W. Eagle, Durham, N. C.: In reply to Dr. Kos's question: It has never been my impression that osteitis or periosteitis had occurred in these cases. If so, the infection would have had to exist for twenty or thirty years in some cases.

Dr. Nelson is speaking of a different condition from the symptomatic styloid process when he states that palpation of the styloid process produces immediate pain; it reproduces the original pain. The patient may jump out of the chair when the symptomatic styloid process is touched, as did the patient Dr. Equen

spoke of. I do not palpate as deep as the hyoid bone. The stylohyoid ligament may become calcified.

Someone asked about the calcification of the stylohyoid ligament. On only two occasions clinically have I found it calcified all the way to the hyoid bone. In the anatomic dissecting rooms, however, many cases may be found among the Negro cadavers.

I have seen patients in whom the styloid process was so prominent that the mucous membrane of the pharynx would glide over this process as the mouth was opened. Such stimulation may produce pain in the ear, and pain of the same type may be produced by stimulation of the endings of the fifth, seventh, ninth and tenth cranial nerves as swallowing takes place.

I thank Dr. Van Alyea for discussing the embryonic origin of the styloid process. One patient, the youngest in the series, who had his tonsils removed at the age of 25, had elongated styloid processes. Most of the patients are at least in their thirties, so that there has been sufficient time for the ossification to take place.

I have seen some patients who, as Dr. Jackson told us several years ago, may have had arthritis of the larynx. They did not have elongated styloid processes, and their condition improved with the wearing of a flannel band around the neck or with the use of salicylates, as Dr. Nelson pointed out.

RADIATION THERAPY FOR CONDUCTIVE DEAFNESS

Report of Results and Discussion of Roentgen and Radium Irradiation

HARRY C. ROSENBERGER, M.D.
CLEVELAND

THE WORK of Crowe and associates at the John Hopkins University has initiated and popularized radium irradiation of the nasopharynx for a certain type of deafness. That radium was successfully used for aerotitis in the recent war is well known from the numerous enthusiastic reports of the air and submarine forces. Bordley[1] stated that irradiation of the nasopharynx resulted in "appreciable useful increase in hearing acuity" in 45 per cent of the children selected for treatment of conductive deafness. He further stated that only 25 per cent of selected adults showed such improvement. Full page advertisements of the radium applicator in the special journals urge its use in such allied conditions as recurring attacks of acute otitis media, obstinate cases of chronic otitis media and certain types of cough and asthma. This is a large order.

MODE OF ACTION

The therapeutic action of the monel metal radium applicator is the effect chiefly of the beta rays on the germinal centers of the lymphoid follicles resulting in lessened mitosis and increased formation of fibrous tissue and thus in shrinkage of the lymphoid mass. The therapeutic objective is the relief of tubal blockage resulting from hyperplasia of the lymphoid follicles and edema of the mucous membrane. These are established facts. The tissue response to roentgen irradiation and the therapeutic objective are identical with those stated for the use of radium.

NATURE OF STUDY

I am reporting the hearing results of 21 patients referred to the radiologic laboratory of Hill, Thomas, Farmer, Sackett and Schumacher over the past five years. The purpose of the reference was roentgen irradiation of the nasopharynx for diminished hearing of conductive type thought to be caused by tubal blockage of lymphoid origin. I also wish to present my reasons for the use of roentgen rather than radium irradiation.

1. Bordley, J. E.: The Use of Radium in the Treatment of Conductive Deafness, Surg., Gynec. & Obst. **84**:839-844 (April, no. 4A) 1947.

Of the 21 patients, 13 were boys and 8 were girls. The age range was from 2½ to 14 years. Reference for irradiation was always preceded by a hearing test, usually an audiometer test of air and bone conduction. In every instance the tonsils and the adenoids had been removed weeks to years previously. In most instances local treatment of the nose and throat had been given together with a trial of tubal inflations by various technics. Postirradiation hearing tests were always made several weeks after the last irradiation to permit the full effect of irradiation to be realized.

SELECTION OF PATIENT

The selection of the patient was on the basis of the history, the otologic examination, the examination of the nasopharynx, either by mirror or by electric nasopharyngoscope and finally the hearing tests. In addition, the patient was showing little if any improvement following standard otologic treatment. The typical patient was one who had had recurring colds, frequently associated with differing combinations of otalgia, stuffiness of the ears, tinnitus and variable hearing. In some instances the patient had had one or more attacks of suppurative otitis media, but in none was the nasopharynx irradiated until the ears were dry and healed.

Otologic examination usually revealed pink, retracted tympanic membranes, although lusterless, thickened membranes were occasionally seen. In no instance was a fluid level or "bubbles" seen as in adult secretory catarrh, but by auscultation with the Toynbee tube one could occasionally readily demonstrate the presence of moisture. In only the exceptional instance did nasopharyngoscopic examination encounter any evidence confirmatory or diagnostic of obstructing lymphoid tissue. More will be said of this later. The audiometric curve was more often flat than tipped in the low tone range.

RESULTS OF IRRADIATION ON HEARING

Of the 21 patients whose nasopharyngeal tissues were irradiated, only 7, or one third, showed significant improvement of hearing, but in several of these the gain amounted to as much as 30 decibels in the critical frequencies. In view of the lack of benefit from treatment prior to irradiation the result is significant. Each patient of the present group had a total of four treatments, and in no instance were subsequent treatments given. It is possible that additional treatments might have increased the percentage of favorable results. One disappointing feature was the recurrence of aural symptoms and of depression of hearing with subsequent colds, although in several patients the incidence of colds seemed lessened.

DIFFERENCES IN RADIANT ENERGY

In making the choice between roentgen and radium radiation I was influenced by the following considerations. Since the filtration of the radium is low, being that afforded by 0.3 mm. of monel metal or steel, the rays which are most effective with this relatively soft radiation are the hard beta rays. The effective radiation is limited to an area of a diameter of about 3 to 4 mm. Beyond this area the radium has no therapeutic effect. On the other hand, using roentgen radiation with the factors 200 kilovolts, 0.5 mm. copper filtration at 50 cm. target skin distance, one can treat the entire nasopharynx thoroughly and evenly.

The factors [2] which were used in the cases which I am reporting were as follows: 200 kilovolts; 0.5 mm. copper plus 2 mm. aluminum; 50 cm. distance; 100 volts over the right and left sides, with a portal of sufficient size to cover the nasopharynx. The treatment was repeated at weekly intervals for four treatments.

ADVANTAGES OF RADIUM IRRADIATION

One advantage claimed for the radium applicator is that of limiting the radiation effect to the definitely circumscribed area close to the tip of the applicator. This presupposes accurate information of the exact location of the offending lymphoid structure. It also implies the technical ability to place the tip of the applicator in precise juxtaposition with the lymphoid area to be treated, with an allowable error in placement of only a few millimeters if benefit is to result.

Another stated advantage of the radium technic is that it is available to the otologist, who should best know the procedure for its introduction and proper placement. The lack of any reported instance of serious mishap attending the otologic use of the applicator is indicative of its relative safety when necessary precautions are observed.

POSSIBLE DISADVANTAGES OF RADIUM IRRADIATION

Opposed to the advantages mentioned are the following possible disadvantages: Of necessity the monel metal applicator is quite straight. It thus becomes impossible to engage its tip in the entrance of the eustachian tube. If the offending lymphoid tissue lies several millimeters within the pharyngeal lumen of the eustachian tube (the tube is about 35 mm. in length) it is doubtful at best whether sufficient radiation would reach it. The exaggerated curve on the eustachian catheter sometimes necessary in order properly to engage the tubal entrance in inflation dramatizes the necessary and understandable

2. Information regarding the roentgen technic was furnished by the radiologic laboratory of Hill, Thomas, Farmer, Sackett and Schumacher.

remoteness of the straight radium applicator tip from this important area. In such a case a poor result would probably ensue.

A second cause of possible failure in properly placing the applicator is the position and the size of the cartilaginous tubal entrance, termed the torus tubarius, which presents variations depending on the child's age. In the young child the torus lies relatively lower and is less prominent than in the adult. Any otologist who will routinely palpate and visualize the nasopharynx through a Killian speculum while doing adenoidectomy will early appreciate the considerable variability of the size of the nasopharynx as well as of the torus in children of the same and children of different ages. This variability must directly affect the certainty of application of the radium applicator.

Not only may the lymphoid tissue producing tubal inadequacy be situated within the lumen of the cartilaginous portion of the tube, but it may occupy an extracartilaginous position. I refer to lymphoid masses adjacent to the torus and typically posterior to the torus, in Rosenmüller's fossa. Another location I have learned to inspect is that fold of mucous membrane called the plica salpingopharyngea. This fold covers an underlying muscle of the soft palate and is often encrusted with hyperplastic lymphoid follicles like barnacles on a keel. These masses may obstruct the tubal entrance.

Unhappily a third location and one quite unflattering in its implication is that of the "recurring" adenoid mass in the usual midline adenoid-bearing region. I believe the two chief causes of this so-called "regrowth" is the pernicious practice of removing the adenoids with too light or no anesthesia together with a failure to engage the adenotome or the curet high enough in the vault of the nasopharynx against the vomer. In other words, an adenoid remnant remains. Whatever the cause, the result regarding the hearing is occasionally deplorable. In these instances there must be accurate information concerning the exact position of the areas to be reached, together with correct positioning of the radium applicator. Naturally the beneficial results of irradiation will be in direct proportion to the attention paid to these details.

In my experience an important difficulty has been in visualizing the nasopharynx adequately in order to ascertain just where the radiation effect should be directed. The passing of an electric nasopharyngoscope through the nostril of a struggling, weeping, apprehensive and cantankerous child is often an exhausting experience for both the patient and the doctor. Too often the information obtained is questionable.

Even with the cooperative patient, the shrinking and anesthetic applications that one must use occasionally distort and disguise the pathologic tissues present so that wrong impressions ensue. The

indirect view obtained with the postnasal mirror, while probably more informing than that provided by the nasopharyngoscope, is too often not obtainable with the young patient. This all adds up to inadequate knowledge of the state of the nasopharynx. In this dilemma recourse is had to the obvious procedure of inserting the applicator to the presumed desirable location and then hoping for the best. Of course, there is the occasional recalcitrant child in whom general anesthesia must be produced before any examination or treatment can be given.

ROENTGEN IRRADIATION

In the two foregoing sections I have given a summary of some of the advantages and disadvantages of radium irradiation of the nasopharynx for deafness. Now what may be said of the relative advantages and disadvantages of roentgen irradiation for this purpose? An important advantage of roentgen irradiation is that a larger field is covered by the exposure. Consequently, whether the obstructing lymphoid tissue is in the tube, in Rosenmüller's fossa, in the posterior pharyngeal wall or on the plica salpingopharyngea it is exposed to the therapeutic ray. Needless to add, this is accomplished without mayhem or fisticuffs. This broader field of irradiation lessens the possibility of misapplication or misdirection of radiant energy.

A theoretic disadvantage inherent in the technic of roentgen irradiation is the necessity of projecting the rays through normal tissue structures to reach the abnormal tissues requiring treatment. Theoretic damage to the skin, the pituitary gland and other structures has been mentioned as a contraindication to this method of irradiation. However, with the treatments in the hands of a radiologist, these arguments would seem to be not serious.

IRRADIATION A HEARING CONSERVATION MEASURE

Since irradiation for deafness has its greatest usefulness in the young, it is not inappropriate to reemphasize the role that this procedure plays in the large field of the conservation of hearing. It is with the young that otologists have their greatest opportunity of usefulness in mending the harm that befalls the hearing apparatus. With adults the same effort often yields only paltry returns, measured in terms of improved or conserved hearing.

This obligation to conserve hearing in the young now transcends the field of the otologist and involves his colleagues, the pediatrician and the family doctor. Armed with chemotherapy and with antibiotics these practitioners now function as otologists in dealing with many of their patients. No longer does the specter of an unresolved otitis media or possible mastoiditis with its complications haunt these busy

doctors. The early administration of the "superdrugs" stops the discharging of the ear and makes a rarity of surgical mastoiditis.

But what are physicians doing about the many ears they are forced to see after the acute inflammation has subsided? Happily, most physicians realize their dual responsibility of curing infection and conserving function. However, too frequently one still sees children who have had an acute infection of the ear ably cared for by a physician who, after the resolution of the infection, lost all interest in the impaired function. All that otologists can do about this is to become more interested in the various aspects of the conservation of hearing.

Another problem encountered in irradiating the nasopharynx for deafness is that of the child who has severe nerve deafness or who is congenitally deaf except for possible "tone islands" which may be of use in his rehabilitation. My attitude toward this is identical with my attitude toward the problem of the removal of diseased tonsils and adenoids of such patients. If there is even the smallest chance of improving the situation by correcting a factor contributing to conductive deafness, the correction should be done. I have referred several such patients for irradiation.

FIBROTIC CHANGES

An important observation may be made regarding the time to institute radiation therapy for deafness. I doubt the necessity or wisdom of routinely irradiating the nasopharynx after every adenoidectomy. Certainly, a thorough effort at accepted otologic treatment should precede irradiation. However, irradiation should not be withheld until irreversible fibrotic changes occur in the tube or the middle ear, rendering permanent a deafness that might have been only temporary.

A second observation has to do with adenoidectomy. The need for irradiation can surely be much reduced by having the patient under full anesthesia, so that the removal of adenoid tissue by curet and adenotome can be thorough and painstaking. Secondary palpation and inspection is an important part of the operation. I have found the circular tonsil punch of much aid in removing lymphoid follicles about the torus and from the lateral pharyngeal wall and the plica salpingopharyngea.

ALLERGY

A final word may be added regarding the surprising frequency of either a personal or a family history of allergy in this group of 21 patients. It probably coincides with the observation that an increasing number of otolaryngologists are making, namely: Allergy is playing an accelerated role in the practice of otolaryngology.

SUMMARY

Of 21 patients with impaired hearing who were selected for roentgen irradiation of the nasopharynx, one third had significant benefit from such treatment after standard otologic treatment had proved ineffective. It is possible that the percentage of patients whose hearing was improved might have been increased by additional roentgen therapy. It is evident that radiation therapy may be administered effectively by either roentgen or radium technic. Some of the advantages and disadvantages of each method are discussed. In order that the radiation technic may not be considered a bonanza for the otologist, the patients must be carefully selected and the results of treatment properly assessed and reported.

10515 Carnegie Avenue.

HEARING REEDUCATION WITHOUT THE USE OF HEARING AIDS

A Report, Analysis and Interpretation of the Results in Fifty Hard of Hearing Persons

VICTOR L. BROWD, M.D.
NEW YORK

METHODS devised to improve the function of impaired organs of hearing without effecting a physical change have been used at various times in the past one hundred years, principally in young subjects whose hearing was severely impaired or who were born deaf.[1] These methods have been both educational and acoustic in nature, but only in recent years, since the great increase in the employment of hearing aids began, have they become available to the many thousands with less profound, acquired impairment of hearing—the hard of hearing; for it was found that when a hearing aid was worn, improvement in hearing, over and above that derived from the amplification of the instrument, could be derived from such treatment.[2] As a result, hearing reeducation (acoustic training) of the hard of hearing has become a common procedure. But practically it is given only after a hearing aid has been fitted and with the express purpose of bolstering the instrument's performance. It must however be pointed out that many hard of hearing patients are unable to wear a hearing aid, namely: those who, because of the degree or the pattern of their loss of hearing, cannot tolerate a hearing aid or tolerate one to a negligible or inadequate degree only, and those whose station, calling or temperament prohibits the wearing of a hearing device. This is no small group; on the contrary, there is good reason to believe that the majority of persons who experience difficulty in hearing belong in it. Strangely enough,

From the Department of Otolaryngology of the New York Polyclinic Hospital.

1. Itard, J. E. M. G.: Traité des maladies de l'oreille et de l'audition, Paris, Méquignon-Marvis, 1821, vol. 2. Urbantschitsch, V.: Ueber methodische Hörübungen und deren Bedeutung für Schwerhörige, Ertaubte und Taubstumme, Vienna, W. Braumüller, 1901. Goldstein, M. A.: The Acoustic Method for the Training of the Deaf and Hard-of-Hearing Child, St. Louis, Laryngoscope Press, 1939.

2. (*a*) Senturia, B. H.; Silverman, S. R., and Harrison, C. E.: A Hearing Aid Clinic, Ann. Otol., Rhin. & Laryng. **52**:131-145 (March) 1943. (*b*) Goodfellow, L. D.: The Re-Education of Defective Hearing, J. Psychol. **14**:53-58 (July) 1942.

they have received no help whatsoever—neither hearing aid nor hearing reeducation. Since they are unable to receive the benefits of a hearing aid, it seems that at least an attempt should be made to provide them with the benefits derived from the reeducational portion of aural rehabilitation programs. Yet, with such a suitable field available, efforts to apply to unaided ears the type of therapy that is used in conjunction with hearing aids are practically unknown. To the best of my knowledge this is the first series of cases reported which directs attention to the possibility that auditory reeducation may be of use in those unable to wear a hearing aid.

FEASIBILITY OF AUDITORY REEDUCATION WITHOUT USE OF A HEARING AID

A patient with, for example, an average hearing loss of 55 to 60 decibels is usually brought to the level of those having a 30 to 35 decibel loss by the amplification of a hearing aid.[2a] Experience shows that his hearing performances only partially reflect this acoustic gain. A program of hearing reeducation is then superimposed, and additional hearing is regularly acquired thereby.[3] What, then, is to prevent a patient with a 30 to 35 decibel average loss from also acquiring hearing if given the same reeducation without a hearing aid? Patients with a 25 and those with a 20 decibel average loss have even greater possibilities. What is to prevent these from being carried to higher levels, and with greater ease, than any patient fitted with a hearing aid? In other words, the proposal to give reeducation of hearing without a hearing aid involves no more than the following: that the same hearing reeducation program regularly employed with benefit in cases in which a patient has first been brought up to a certain level by a hearing aid be given without a hearing aid in cases in which the patient is already at such a level. Since there appeared to be no obstacle to such a procedure, reeducation was given directly to the ears of a number of hard of hearing patients.

THE PATIENTS TREATED

The patients referred to in this report are the first 50 of a large number of consecutive, unselected persons applying for the relief of a troublesome and noticeable auditory impairment of more than several years' standing.

The duration of impairment ranged from several years to several decades—an average duration of twelve years; the age at which difficulty was first noticed, from 8 to 55 years—average 28; the age at

3. Silverman, S. R.: Training for Optimum Use of Hearing Aids, Laryngoscope **54**:29-36 (Jan.) 1944.

the time treatment was given, 20 to 57 years—average 40. All recalled that at some time in the past they had heard well.

Previous Therapy.—A few had never received any treatment; the rest had undergone one or more of the medical or surgical procedures commonly used in the treatment of defective hearing; all had consulted a physician about their ailment on more than one occasion. Some had been fitted with a hearing aid, but in their estimation had not been benefited sufficiently to warrant wearing it; several wore a hearing aid on certain occasions; a few wore one regularly.

Progressive Character of Hearing Impairment.—In every case the hearing had become poorer since the onset. In some the deterioration was gradual; in most it occurred in a steplike fashion every few years. Several who thought they had maintained a certain level revealed a progressively narrowed circle of activity instead.

Degree of Impairment.—In order to demonstrate the extent and the nature of the improvement and the types and degrees of hearing loss which can be benefited, the degree of impairment was carefully determined and indicated in several ways:

(*a*) By response to pure tones: The threshold was obtained on several successive days with a standard audiometer in a room with a background level of noise of 10 decibels; the lowest threshold obtained was selected. The average of the decibel losses from frequency 128 to 8192, inclusive, was called the "hearing loss." With the exception of 5 cases of unilateral impairment, the smallest average hearing loss in the series was 20 decibels in the better ear; the greatest, 90 decibels.

(*b*) By disability: This evolved into the replies of patient (and relative) to a questionnaire calling for the amount of difficulty experienced in a number of situations. In addition, a single word descriptive of the over-all hearing status was recorded. The situations selected were those which appeared most frequently in the histories, those volunteered most frequently by patient and relative, and those in which people are particularly anxious to hear properly. Such a disability questionnaire automatically becomes a unique test of the impairment, for in the hard of hearing there is (as shown in figure 1) an unusual variation of disability in these different situations, a variation governed by factors other than the acoustic impact of sounds reaching the peripheral organ. Standard hearing tests, though useful in many other ways, are unable to demonstrate this variation, for they indicate the disability in only one situation—the one in which they are performed—and may on that account grossly misrepresent the patient's performances in other situations or fail to depict many of his difficulties, his regression or his progress. The questionnaire has these additional advantages: It is a cross section of countless observations made under a variety of con-

ditions; its recording is practically free of a human element or a margin of error; it is actually the standard used by the patient and those about him for judging acuity of hearing and so becomes the most critical (and eventually the final) test of the merits of a hearing therapy or a hearing aid. The degree of hearing disability expressed by the patients in this series was in most instances that shown in figure 1.

(*c*) By the use of the term "hard of hearing," "*hard* of hearing" (*Schwer*hörigkeit, *dur* d'oreille) expresses difficulty in hearing, as opposed to failure to hear. The difficulty is in interpreting what is heard, and coincides with the invasion of tones of the conversational speech area

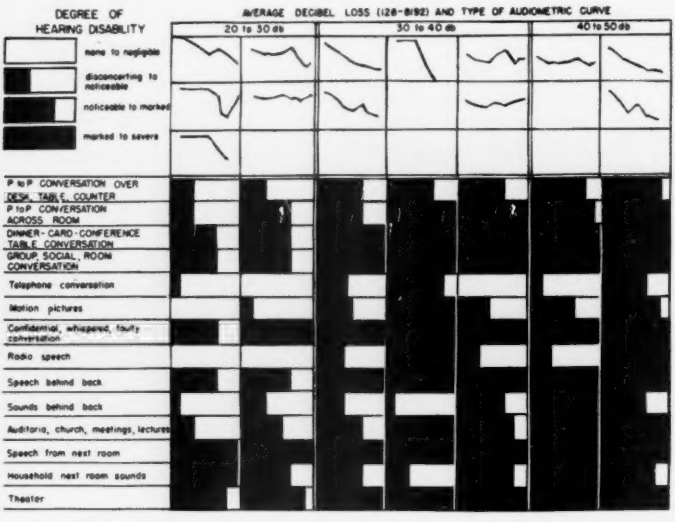


Fig. 1.—A composite picture of the degree of hearing disability noted in various situations by 200 hard of hearing patients with an average loss of 20 to 50 decibels in the better ear. The picture is a composite of replies to a questionnaire. Very hard of hearing persons fall in the 30 to 40 decibel group.

of the better ear. This is an abrupt change, the only change—from a state of no disability to one of awareness or evidence of disability, from no desire for assistance to the need and seeking of assistance—that occurs in all the grades of subnormal hearing. The audiometer cannot always be depended on to portray the degree of hearing disability, but it, too, indicates that there is a clearcut boundary of the hard of hearing state and serves to locate it acoustically (close to 20 decibels), for almost all persons with a 20 decibel average loss in the better ear have a noticeable difficulty of hearing and seek relief for it, whereas

those requiring less than 20 decibels of intensity rarely realize or show that they have a defect of hearing. There appear then to be only two well defined classes of patients with impaired hearing: those who are in difficulty and those who are not, and since the term "hard of hearing" denotes a noticeable or a troublesome degree of impairment, it is, when properly used, the least arbitrary way of separating the two. All the patients in this series were hard of hearing, and that term applied to them, since theirs was a troublesome degree of hearing impairment and (with the exception of 5 who had unilateral impairment) they showed a hearing loss of 20 decibels or more in the better ear.

Pattern of the Impairment.—As indicated in the air conduction audiograms in figures 2 and 3, four types of graph were most frequently encountered: (1) the "flat" loss, (2) the "flat" loss with a peak at 2048, (3) the abrupt high tone loss and (4) the gradual high tone loss.

Types of Peripheral Lesion.—From the audiograms (bone and air), the patient's statement of the effect of noise and the telephone on his ability to understand speech, the appearance and motility of the tympanic membrane and from functional testing of the eustachian tube, the hearing impairment appeared in most instances to have been caused by one of the following five types of peripheral lesion: (1) chronic suppuration of the middle ear (healed and unhealed), (2) chronic catarrh of the middle ear or the eustachian tube, (3) ankylosis of the stapes, (4) involvement of the first turn of the cochlea (abrupt high tone loss) and (5) involvement of the auditory nerve (gradual high tone loss). Although the suppurative type predominated, each of these five types had a fairly equal representation. In any event individual modifications in the therapy were dictated primarily by the amount of hearing loss and not by the site or the character of the lesion.

Barring those with a meager knowledge of English (these were not accepted), the 50 patients whose treatment is reported appear to represent sufficiently well the next 50 patients who will consult an otologist, an outpatient department and a hearing aid company for a long-standing and troublesome disorder of hearing.

THE THERAPY

A normal hearing ear can distinguish 1,500 different pitches and 325 degrees of loudness—a third of a million tones in all. The usefulness of such an ear lies more in this ability to detect small differences in the sound patterns it hears than in its ability to hear faint or distant sounds; for it is the individuality of the sounds heard by the normal ear that furnishes it reliable information with little effort, and constitutes the stimulus which maintains its low hearing threshold. In

TABLE 1.—*The Results of Auditory Reeducation of Patients 1 to 29 Without the Use of Hearing Aids*

Patient	Initials	Sex	Age	Age at Onset of Disability	Number of Years Hard of Hearing	Impression of Type of Peripheral Lesion (Better Ear)	Average Db. Loss (128-8192) Better Ear	Degree of Hearing Disability Before Hearing Reeducation †	Degree of Hearing Disability (Months, Years) After Completion of Hearing Reeducation †	Tinnitus, Itching, Pressure, Etc.		Consonant Articulation Test			
										Before	After	Distance in Feet	Words and/or Syllables	Errors Before Hearing Reeducation	Errors After Hearing Reeducation
1	S. S.	M	46	42	4	Otitis media, adhesive	20	Noticeable	9 mo. None	None	None	25	50	22	6
2	M. G.	F	38	35	3	First turn coch.	20	Noticeable	9 mo. None	Mrkd.	None	25	50	18	3
3	E. C.	M	31	26	5	First turn coch.	20	Noticeable	9 mo. None	None	None	..	..	..	..
4	G. G.	M	53	48	5	First turn coch.	21	Noticeable	4 mo. None	None	None	25	110	20	8
5	L. C.	F	48	43	5	OMCC	21	Marked	8 mo. None	None	None	25	50	15	4
6	I. S.	M	41	37	4	Dry perforation	23	Noticeable	5 mo. None	Mdrt.	Occas.	25	110	39	12
7	R. R.	F	32	29	3	Nerve deafness	24	Noticeable	1 yr. Occas.	Mdrt.	None	15	150	40	15
8	S. B.	F	35	25	10	Otosclerosis	25	Noticeable	6 mo. Occas.	Mdrt.	Occas.	15	60	33	5
9	E. G.	F	37	20	17	OMPC, healed	26	Severe	9 mo. None	Mrkd.	None	15	60	39	9
10	S. S.	M	29	16	13	OMCC	26	Marked	2 yr. Occas.	Mrkd.	None	15	60	44	15
11	E. J.	F	42	30	12	OMCC	27	Marked	2 yr. None	None	None	15	100	40	10
12	F. B.	F	57	54	3	Cochlear	28	Noticeable	3 yr. None	None	None	..	..	..	..
13	H. L.	F	22	16	6	Unhealed radical mastoidectomy	30	Marked	2 yr. Occas.	None	None	..	..	..	..
14*	A. B.	M	47	32	15	First turn coch.	30	Noticeable	2 yr. Notice.	Mdrt.	Mdrt.	15	60	13	7
15	M. T.	M	56	51	5	Nerve deafness	32	Noticeable	1 mo. None	None	None	15	60	31	7
16	B. E.	M	32	26	6	Otosclerosis	32	Noticeable	3 yr. None	Mdrt.	None	..	..	..	..
17	R. M.	F	23	18	5	OMCC	32	Marked	6 mo. None	Occas.	None	15	60	50	21
18*	P. G.	M	31	21	10	OMPC, healed	33	Marked	2 yr. Notice.	None	None	15	60	44	26
19	M. M.	F	42	24	18	OMCC	34	Marked	3 yr. Occas.	Occas.	Occas.	15	60	21	5
20*	M. H.	M	38	28	10	Otosclerosis	34	Noticeable	1 yr. Notice.	Mrkd.	Occas.	15	150	67	14
21	S. M.	M	57	27	25	Dry perforation	35	Marked	3 yr. Occas.	Mdrt.	None	15	60	..	11
22	B. K.	F	24	12	12	OMPC, healed	36	Marked	6 mo. Occas.	Mdrt.	None	15	60	51	18
23*	H. L.	M	48	41	7	Nerve deafness	36	Marked	3 mo. Notice.	Occas.	Occas.	15	60	36	17
24	H. G.	M	33	18	15	Dry perforation	41	Marked	3 yr. Occas.	None	None	..	..	..	..
25	A. U.	M	53	30	23	Otitis media, progressive	42	Severe	9 mo. Occas.	None	None	15	60	46	21
26*	S. F.	F	29	23	6	Otosclerosis	46	Severe	6 mo. Marked	Mrkd.	Mdrt.	..	..	..	..
27	F. W.	F	51	45	6	First turn coch.	51	Severe	3 mo. Occas.	None	None	5	30	35	20
28	A. F.	M	51	8	43	OMPC, healed	52	Marked	6 mo. Occas.	Occas.	None	15	60	32	13
29*	D. O.	F	49	22	27	Undetermined	60	Severe	6 mo. Notice.	Mrkd.	Mdrt.	..	..	..	..

* Result was unsatisfactory.
† Patient's (relatives') description.
OMCC indicates chronic catarrhal otitis media; OMPC, chronic purulent otitis media.

an impaired ear many tones by which sounds could be identified are missing, and much of the difficulty which such an ear experiences arises not from an inability to hear sounds but from the fact that too many sounds appear to be alike. Not only will "mare" sound like "bear," "hub" like "cup," "teeth" like "feet," but a bell may sound like a cough, a voice like someone rapping on a door, a whistle like china.

In the hard of hearing state one observes, then, an appreciable amount of hearing power which is of little or no use to the patient because with it he is unable to appreciate the difference between many sounds or he mistakes one sound for another. As a result, there is an increasing tendency to disregard such sounds, a raised threshold of response to them and for all practical purposes a loss of this much hearing power. In proportion to its amount, the latter makes for greater difficulty of recognition of sounds which up to now were plainly heard, and so on.

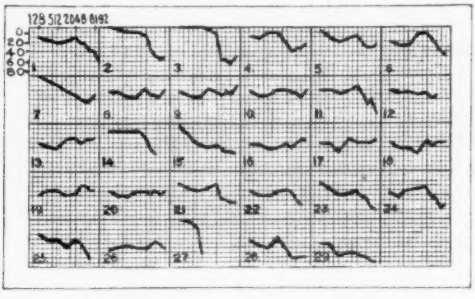


Fig. 2.—Audiograms of the better ears of patients 1 to 29.

If this process is to be reversed, if that area of the hearing range which is not directly affected by the pathologic changes occurring in the ear is to remain available to the patient, it becomes apparent from the foregoing statement that as many as possible of the sounds which fall in this area be told apart and correctly interpreted by him. Interpretation of sounds and discrimination of sounds are therefore important features of reeducation of hearing, and since speech is the most important and most frequently heard of the day's sounds, speech is the principle vehicle employed and its interpretation one of the first steps in the therapy.

Improved Interpretation and Hearing of Speech.—Seated face to face with the patient at a distance at which a conversational tone of voice can just be comfortably heard by him, the speaker delivers simple statements concerning a single topic at conversational loudness and prevents visual recognition of them by holding a 5 by 8 inch (12.5 by

TABLE 2.—*The Results of Auditory Reeducation of Patients 30 to 43 and 48 to 50 Without the Use of Hearing Aids*

Patient	Initials	Sex	Age	Age at Onset of Disability	Number of Years Hard of Hearing	Impression of Type of Peripheral Lesion	Average Db. Loss (128-8192)	Hearing Disability (D)‡: Before Hearing Reeducation: Room Sounds	Voice	Interpretative Conversation	Interpretative Whisper	Localization of Sounds	After Hearing Reeducation: Room Sounds	Voice	Interpretative Conversation	Interpretative Whisper	Localization of Sounds	Tinnitus, Itching, Pressure, Etc.: Before	After	Consonant Articulation Test: Distance in Feet	Words and/or Syllables	Errors Before Hearing Reeducation	Errors After Hearing Reeducation
30						Otitis media, adhesive	45	..	..	D	D	..	..	..	..	..	..	Const.	None	15	60	50	16
31						First turn coch.	29	..	..	D	D	..	..	..	..	..	..	Mdrt.	None	..	..	..	..
32						OMCC	38	D	D	D	D	..	..	..	..	..	..	Const.	Const.	15	60	41	12
33						OMPC	50	D	D	D	D	..	..	..	..	..	..	Mrkd.	Occas.	5	60	66	21
34						Otosclerosis	34	D	D	D	D	..	..	..	..	..	..	Mdrt.	Occas.	5	60	48	18
35	*					OMCC	30	..	..	D	D	..	..	..	..	..	..	Mrkd.	None	..	..	..	..
36						Healed radical mastoidectomy	58	..	..	D	D	..	..	..	..	..	..	None	None	..	..	..	..
37						Otitis media, progressive	61	D	D	D	D	D	D	..	..	D	..	None	None	..	..	..	..
38						Healed radical mastoidectomy	55	D	..	D	D	..	..	..	..	..	..	Occas.	None	..	..	..	..
(Numbers 39-43: Patients with Normal Hearing in Better Ear. Poorer Ear Treated)																							
39	M. A.	F	34	24	10	First turn coch.	28	D	D	D	D	D	..	..	..	..	..	Const.	None	..	..	..	..
40	J. S.	F	28	16	12	Dry perforation	24	D	..	D	D	D	..	..	..	..	..	Const.	None	..	..	..	..
41	F. L.	M	51	41	10	Cochlear	39	..	..	D	D	D	..	..	..	..	..	Const.	None	15	60	61	22
42	H. R.	F	45	38	7	Nerve deafness	82	..	..	D	D	..	..	..	..	..	..	Const.	Const.	15	110	57	16
43	L. R.	M	28	3	25	OMPC	55	D	D	D	D	D	..	..	..	D	..	None	None	..	..	..	..
(Numbers 44-50: Patients with Impairment of Hearing in Both Ears. Better Ear Treated)																							
44	F. W.	F	21	18	3	Nerve deafness	75	(Numbers 44-47: Hearing reeducation given with a hearing aid, not attempted without)															
45	J. B.	F	32	18	14	Nerve deafness	75																
46	R. Z.	F	21	18	3	Nerve deafness	Total																
47	E. A.	F	28	8	20	Nerve deafness	Total																
48†	R. P.	F	30	25	5	Otitis media, progressive	50	(Numbers 48-50: Patients refused to complete treatment because of slow progress)															
49†	E. G.	F	48	15	33	Otosclerosis	48																
50†	E. L.	M	42	30	12	Cochlear	37																

* Patients 30 to 38 are patients 1, 4, 5, 6, 8, 11, 24, 25 and 28 of table 1, seeking treatment for the other, poorer ear.
† The result was unsatisfactory.
‡ Patient's statements.

20 cm.) card at an angle of 45 degrees in front of his mouth. The patient is asked to repeat whatever he hears, and if correct he is so informed. If not, the card is removed and the sentence repeated. This is continued for several minutes. The patient and relative seldom fail to express surprise at what they consider a good performance; for the distance is usually two, three or even five times that which was believed to be the limit for his hearing of conversation. This serves to illustrate how little of his hearing power the hard of hearing person utilizes.

When possible, this procedure is repeated the following day, and daily thereafter, and additional improvement is noted each time. The reason for this improvement is that having been given the opportunity to interpret and identify them, the patient discovers that many of the vague, incomplete or unfamiliar speech patterns received become adequate and take on full meaning. On this basis alone his understanding of speech can be improved, for there are audible features of speech

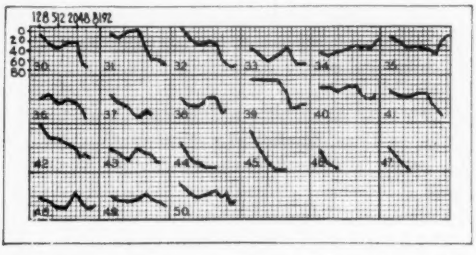


Fig. 3.—Audiograms of the poorer ears of patients 30 to 43 and the better ears of patients 44 to 50.

patterns, beside pitch and loudness, which make this possible—accent, rhythm, inflection and duration. For purposes of comparison and contrast, complete speech patterns are also provided by having the patient listen to speech through a speaking tube.

Further improvement of the understanding of speech is subsequently conferred by correcting misinterpreted speech. The latter rests principally with a misinterpretation of a number of the individual speech elements or sounds (the consonants and the vowels). These are corrected in the following way: Monosyllabic word lists of a length sufficient to include all the speech sounds of English are delivered in the manner just described for conversation. The replies disclose that certain speech sounds, particularly the consonants, are regularly mistaken for others by the patient. Speech sounds mistaken one for the other are then incorporated in individually prepared word lists in a manner calculated to set off their differences—in pitch, loudness, impulse, duration. For example, if the sounds "n," "l" and "d" appear

interchangeably in the patient's replies, they can be arranged in this fashion:

die, lie, nigh
low, no, dough
an, Al, add
day, nay, lay

and so on. The routine described for the interpretation of conversation, with its corroboration or correction, is then followed. In calling off each row, one word at a time, the patient is forced to depend solely for the correctness of his reply on any small differences which his ear is able to detect in the patterns of "n," "l" and "d." Even though these differences may never become as striking as they are to a normal hearing ear, the patient is generally able in the course of time to discriminate between, and correctly interpret by ear, most or all of the misinterpreted speech sounds. Each one so reclaimed naturally becomes the source of a certain amount of improvement in the understanding of speech throughout the day.

When a satisfactory degree of facility in understanding is attained at the distance originally selected, it will be found that the intervening distance may now be increased, the voice lowered or the context made more difficult, with little effect on the caliber of the performance. Eventually speech is presented to the patient in what had been for him more difficult situations (fig. 1). In this way, the understandable speech acquired as described is made to act as the pacemaker in the regaining of discrimination of sounds and the lowering of the threshold of hearing for speech—thus reversing the process whereby poor discrimination of sounds and a raised threshold of response to sound, acting reciprocally, had created increasing difficulties in hearing. Many examples of this important relation of sound interpretation to hearing threshold can be given. One will suffice, the finding of Macfarlan [4] that words spoken in sentences are picked up at a 10 to 20 decibel lower level than are single words.

When reeducation is given to the poorer ear, the auditory canal of the better ear should be closed. The patient's finger is the most practical means of accomplishing this.

Improved Hearing for Sounds Other Than Speech.—Speech occupies a large and exceptionally sensitive area of the human hearing range, and in the course of acquiring improved hearing for speech many thousands of tones become audible. The acquisition of such tones fills in gaps in many sound patterns which are heard throughout the day and so enables the patient to recognize these and respond to them. Thus, improved hearing for many sounds other than speech follows

4. Macfarlan, D.: Speech Hearing Tests, Laryngoscope **55**:71-115 (Feb.) 1945.

automatically in the wake of better heard speech. On the other hand, a number of sounds still remain unheard and in all probability will not be acquired unless they are "gone in for" individually. Of these, the most useful or most desired by the patient are selected first. They are for the most part sounds of bells, buzzers, whistles and other sounds commonly used as signals; ticking of the clock, rapping on doors, kitchen and household sounds; sounds encountered by the patient in his office, shop or occupation.

The principles involved in conferring hearing for sounds of this sort are no different from those described for improving the hearing of speech: (1) Unrecognized, vaguely familiar sounds are poorly heard sounds, and (2) the threshold of response is higher with these than with readily recognized sounds of a like intensity. The patient is therefore given many opportunities of identifying at close range the inadequate sound pattern he receives with the object that produces it. If necessary, this is contrasted with similar sounding objects. As he becomes familiar with its sound and demonstrates his ability to recognize it, it is presented to him from increasingly greater distances. Eventually the sound is produced unexpectedly from time to time, and then if he is able to identify it regularly, this is taken as adequate proof that his threshold of hearing has indeed been lowered for it and he will be able to hear it henceforth without further assistance. It is not difficult to confer hearing for sounds of this type, for there are not many of them that the patient needs greatly or desires to have, and they do not have to be identified as accurately as the speech sounds, in order to be heard well.

Comment.—Sound is the only therapeutic agent employed, sound in a number of forms, at various levels of loudness or distances and in various situations. The principal vehicle used is speech (conversation, sentences, words, syllables), delivered directly from mouth to ear. As an alternate, artificially produced speech (recordings, sound track, etc.) appears to have little to offer when normally delivered speech is available, it was eventually discarded. Its sound patterns bear the same relation to purely air-borne speech that a patois or provincial speech bears to an official language—something to be learned and then unlearned before speech as ordinarily received can be understood. However, no source or form of sound, complex or pure, is omitted if judged useful for a patient. The approach is the same for all patients, but individual variations are the rule. None of the work is done in groups. The interval between visits is gradually increased, but treatment continues as long as progress is reported or observed, or until a level commensurate with the patient's needs is reached. This generally appears by the end of three months, although several weeks of care is found to be adequate in some cases, while six months of supervision may be necessary or profitable in others.

Like the fitting of a hearing aid, the teaching of lip (speech) reading has come to be regarded as an essential part of all hearing rehabilitation programs. Experiences with lip reading in this series do not bear this out but lead to the following conclusions: In the patient whose hearing is severely impaired, vision is indispensable for satisfactory understanding of speech and in many of these reeducation must be supplemented by the teaching of lip reading. When hearing reeducation is given to patients with less than a 50 decibel loss, no benefit is derived from the teaching of lip reading; on the contrary it impedes or detracts from the central purpose of the program, namely, that the patient's attention be directed to auditory stimuli and away from the visual, which he had been depending on more and more. On that account the formal teaching of lip reading is deliberately omitted in all cases in which hearing is not severely impaired. It is felt that this move affects the outcome favorably.

The therapy described does not differ in principle from the hearing reeducation programs usually suggested or employed for augmenting the performance of hearing aids, but it does differ from them in the following respects: Its duration and scope are not predetermined; it avoids the teaching of lip reading; it places as much importance on improved hearing of sounds as it does on improved understanding of speech; it devotes special attention to hearing in various situations, and is given directly to the human ear. The last has great significance, for the ear has these advantages over a hearing aid: (*a*) a constant reference level, available at all times and in all situations, (*b*) a wider range of comfortable hearing and a wider frequency range, and (*c*) binaural hearing in most cases. Furthermore, the patient has a greater stake and more to gain in learning to overcome the shortcomings of his own ear rather than those of the hearing aid, and he is free of the social, economic and psychologic drawbacks connected with an instrument. It might be well to add that the program was administered personally by an otologist.

THE RESULTS

Reporting of Results.—A comparison of the hearing disability of most recent date (as stated by patient and relative on a duplicate of the original disability questionnaire) and the hearing disability at the start of treatment was taken to be the best indication of the improvement brought about by the treatment. This is shown in tables 1 and 2 and figures 1 and 4.

When the series was started, no change was expected or demanded of the audiogram, but the rapid acquisition of faint sounds called for audiometric retesting. Audiograms were therefore taken from time to time. Surprisingly large pure tone gains occurred in some of the cases, but since there appeared to be no constant relation between these

and the clinical gains, they are not included in this report. Some of the largest and most unusual of the clinical gains in the series were made in the face of an unchanged audiogram. This should occasion no surprise, for the threshold is much lower, as a rule, for the complex sounds of daily life than for pure tones. For example, in comparing the hearing loss for numbers heard over the Western Electric 4A phonograph-audiometer with that shown by the 2A pitch audiometer, Macfarlan [4] pointed out that the numbers were generally heard at a very much fainter level than were the pure tones.

Word list scores were recorded before and after treatment in most of the cases and are reported here (tables 1 and 2). As with all other single tests of hearing, it is difficult to formulate a quantitative relationship between them and the everyday hearing performances of the patient. However, since world list scores are currently used as a measure of the gain derived from a hearing aid, they provide a means for comparing such gains with those derived from hearing reeducation.

The more interesting of the clinical gains were recorded in the form of "progress notes" kept in each case. These are also reported, and an explanation is offered to account for them.

The Results.—Tables 1 and 2 and figures 2 and 3 give the results.

Progress Notes.—These notes concerned hearing gains about which the patient volunteered information from time to time. These gains consisted of an improved understanding of speech and a newly acquired hearing for sounds other than speech. The latter type of gain constitutes the most interesting and significant feature of this report, because the sounds were such as had not been heard in many years, and the hearing of them was acquired without special training. They were of the following sorts: room, household, occupational and office sounds; sounds of bells, buzzers, door rapping, chimes, clocks, water running in basins and tubs, dishes, ornaments, etc.; sounds from an adjacent room; sounds coming through closed doors; sounds (voices and radio) coming through walls and floors from an adjacent apartment; sounds of rain, distant thunder or airplanes, and the hum of street sounds. In some cases the hearing of such sounds was acquired in a few days; in others, in a few weeks; in others, after a few months.

Analysis of Results.—The "satisfactory" hearing levels and the "occasional" disabilities referred to in the following paragraphs are indicated in detail in figure 4.

(*a*) Of 46 consecutive, unselected patients with all types and durations of hearing loss who were treated without a hearing aid, only 9 (1 of 5) continued to have either a disabling or a noticeable degree of impairment. The remaining 37 (4 of 5) showed either no disability (21) or only occasional evidence of it (16).

(*b*) The 12 hard of hearing patients with a 20 to 30 decibel loss in the better ear all attained a satisfactory hearing level (no hearing disability in 9, only occasional evidence of disability in 3); yet there are few instances or situations (fig. 5) in which persons in this group of the hard of hearing are able to tolerate, or benefit by, a hearing aid.

(*c*) Of the 21 hard of hearing patients with a 20 to 35 decibel loss in the better ear, 18 (6 of 7) reached a satisfactory hearing level (no hearing disability in 12, only occasional disability in 6); only 3 (1 of 7) failed to reach such a level. This group represents 60 per cent of the patients of this series: there is every reason to believe that

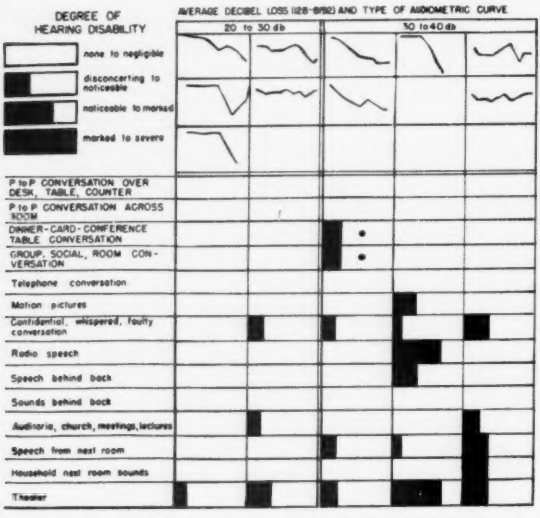


Fig. 4.—A composite picture of the level of hearing attained through auditory reeducation without the use of hearing aids by 21 of 26 hard of hearing patients with an average loss of 20 to 40 decibels in the better ear. The picture is a composite of replies to a questionnaire. The black dots indicate that there was disability in noisy surroundings only.

more than half the patients who seek help for a hearing impairment belong in it. Yet (as shown in figure 5) this large group is, with few exceptions, acoustically unsuited for hearing aids—not tolerating them or deriving no benefit from them, either in all or in the most needed situations. Corroborating this finding is one of the recommendations of the Committee on Hearing Conservation of the American Academy of Ophthalmology and Otolaryngology[5]: "A hearing aid is

5. Conservation of Hearing: The Otologist's Role in the Fitting of Hearing Aids, Committee on the Conservation of Hearing, Tr. Am. Acad. Ophth. **50**:215-217 (July-Aug.) 1946.

indicated when the threshold of hearing of the better ear is impaired across the speech range by 35 decibels or more." In addition Carhart and Thompson [6] stated that "the person must have a degree of loss which lies within the range where hearing aids give promise of useful compensation. . . . Generally speaking, patients whose 512-2048 c.p.s. averages for the better ear lie between 45 and 75 decibels are most effectively helped [by a hearing aid]."

(*d*) Of the 11 hard of hearing patients with a 35 to 52 decibel loss in the better ear, 6 reached a satisfactory level of hearing (the same level as shown for the 30 to 40 decibel group in figure 4), report-

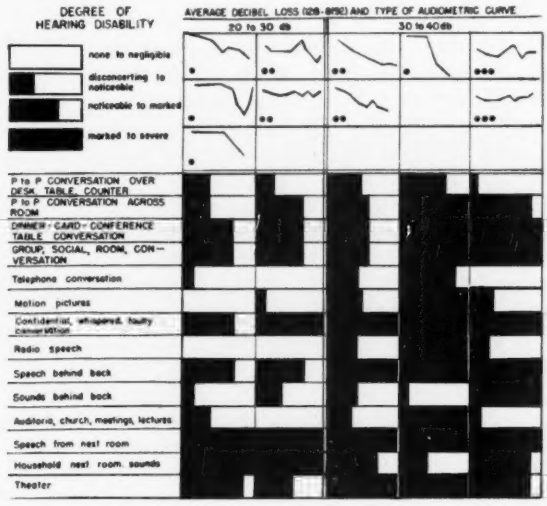


Fig. 5.—A composite picture of the level of hearing attained through hearing aids by 100 hard of hearing patients with an average loss of 20 to 40 decibels in the better ear. One black dot in an audiogram means that the patient was unable to tolerate a hearing aid; two black dots, that the patient found a hearing aid useful or tolerable only in such places as auditoriums; three black dots, that the hearing aid was useful only in auditoriums, moving picture and other theaters and for interviews.

ing only occasional disability; 5 failed to improve sufficiently. Patients in this group are for the most part acoustically suited for a hearing aid and in that respect could be fitted; yet many of these are unsuited because of their station, calling or temperament.

(*e*) Reeducation was directed to the poorer ear only when the patient complained of one or more of the following disabilities peculiar

6. Carhart, R., and Thompson, E. A.: The Fitting of Hearing Aids, Tr. Am. Acad. Ophth. 51-354-361 (March-April) 1947.

to monaural hearing: turning the better ear toward conversation or whispered speech directed to the poorer ear, inability to hear voices and room sounds when lying on the better ear, and difficulty in localizing the source of sounds. In 14 cases the therapy was directed to the poorer ear. (In 9 the better ear was hard of hearing; in 5 the better ear was normal.) All the patients reached a satisfactory level of hearing (table 2): no disability in 11; only occasional disability, and then with confidential or whispered speech, in 4.

(*f*) Two thirds of the patients complained of discomfort in the ears (tinnitus, pressure or itching). There were 22 with such symptoms who were brought to a satisfactory hearing level; only 2 of these failed to report a diminution of symptoms (in the poorer ear in both), whereas 16 became symptom free. On the other hand, there were 5 who did not reach a satisfactory hearing level; none of these became symptom free, and 3 failed to note any diminution of the symptoms.

(*g*) To date, with more than three fourths of the patients responding to periodic reexamination, no patient who reached a satisfactory level has reported a regression of hearing and 5 have maintained their improvement for three years. A number of patients reported transient regressions. These seldom lasted more than a day and were followed by an abrupt return to a satisfactory level. They were invariably the result of mental fatigue or preoccupation and were regularly associated with some trying or worrisome incident. In a number of patients further gains were made after completion of the reeducation program.

INTERPRETATION OF THE HEARING GAINS

In a large group of unselected hard of hearing patients, hearing gains were obtained by directing therapy to the cerebrum without the use of pharmacologic, physical, mechanical or surgical measures. This can be explained in one or the other of two ways:

1. The entire amount of the disability, or the progressive increase therein, which a hard of hearing patient exhibits (by poor interpretation and response to daily sounds or those of hearing tests) is accounted for by pathologic change occurring in the peripheral hearing mechanism, and the hearing gains reported merely represent an increased use which the brain has been taught to extract from an impaired ear. This without question accounts for a part of the gains—small, slowly acquired gains—but it cannot be reconciled with sudden or appreciable gains, newly acquired hearing of sounds of a loudness well below the threshold of the initial audiogram (see under "Progress Notes," page 523) or extraordinary gains shown by the unused (poorer) ear. The following explanation of these is far more satisfactory.

2. Only part of a hearing disability (exhibited by test or otherwise) can be accounted for by peripheral pathologic change; the remainder,

a superimposed nonpathologic hearing disability of central origin, the result of circumstances arising from the hard of hearing state itself, is the principal source of the gains reported. There is a normal cerebral diminution of hearing in narcosis, fatigue, preoccupation and other temporary states. The hard of hearing state (with its impairment of the keenest of the senses, its faulty interpretation of sounds and breakdown of the chief means of communication) is a state of continuous uncertainty and ineffectual effort. It would be surprising to find, after many years of it, no change in attitude toward or response to sound, no diminution in the extent to which sound is employed, and no progressive cerebral diminution of acuity of hearing, over and above that due to peripheral change. The poorer ear, an ear whose situation should make it unusually susceptible to changes such as these, appeared to offer a good opportunity to demonstrate the role which circumstances alone play in defective hearing. The striking gains made by these ears through hearing reeducation lend strong support to the explanation here offered of the source of the gains reported. There is a great temptation to look on all losses of hearing, especially those indicated by tests of hearing, as being derived from a single source only—pathologic change—and not likely to be altered by anything else. It must be remembered that in tests of hearing, as well as in daily hearing, both central and peripheral hearing are represented and are being tested simultaneously and must each be taken into account in the interpretation of all losses (or gains), particularly in cases of long standing. The interpretation here offered of the source of the gains obtained makes only one demand, a not unreasonable one: that the familiar types of pathologic change present in the ears of hard of hearing persons be not considered to offer quite as much acoustic impedance and to be as progressive in character as otologists have been inclined to believe. The least that can be said for such a concept is that it can lead to attempts to free a portion of hearing losses which might otherwise remain untapped.

INTERPRETATION OF THE RELIEF OF AURAL SYMPTOMS (TINNITUS, ITCHING, FULNESS)

When a satisfactory level of hearing was reached, symptoms disappeared because: 1. Newly acquired outside sounds were masking the physiologic body sounds so often heard when hearing is impaired. (Saltzman and Ersner [7] have since observed that a hearing aid often relieved tinnitus, and they have offered the same explanation.) 2. The tension and fatigue of the hard of hearing state disappeared and with them the tinnitus, itching, fulness and pressure which so often are a

7. Saltzman, M., and Ersner, M. S.: A Hearing Aid for the Relief of Tinnitus Aurium, Laryngoscope **57**:358-366 (May) 1947.

part of fatigue and tension. 3. With the diminution in hearing difficulties the patient became less "ear conscious" in general and thereby less conscious of symptoms arising in the ear.

CONCLUSIONS

Auditory reeducation is an effective therapeutic measure indicated in all degrees and patterns of hearing loss of long standing and in all situations in which an untroublesome level of hearing has not been, or is not likely to be, reached or maintained through other measures.

Though generally thought to be a procedure which can be given only with a hearing aid, auditory reeducation may be given effectively with or without a hearing aid. On the other hand, a hearing aid seldom provides a satisfactory level of hearing without auditory reeducation.

As a rule, those with more than a 40 decibel average loss between the frequencies of 128 and 8192 cycles per second in the better ear require both hearing aid and hearing reeducation, but some patients with a loss as great as 50 decibels can be brought to a satisfactory level without a hearing aid.

As a rule, those with less than a 40 decibel average loss between 128 and 8192 in the better ear can attain a satisfactory level of hearing through auditory reeducation without a hearing aid, but some require both hearing aid and hearing reeducation.

Patients with a 20 to 35 decibel loss in the better ear can tolerate a hearing aid in very few situations in the course of the day. On that account, they have in the past been forced to remain hard of hearing, although numerically they constitute an appreciable portion of the hard of hearing group. When given auditory reeducation alone few of them fail to attain a satisfactory level of hearing.

Hearing reeducation without a hearing aid is also indicated for the following persons: 1. Those with a 35 to 50 decibel loss in the better ear who are acoustically suited, but whose station, calling or temperament makes them unsuited, for a hearing aid. 2. Those unsuited for a hearing aid whose tinnitus or other aural symptoms are caused by the hearing loss itself. 3. Those who have had a hearing aid fitted to their poorer ear because they were unable to tolerate a hearing aid in the better ear. Such patients can attain a satisfactory level of hearing through auditory reeducation alone and thus are relieved of the necessity of resorting to a gauche procedure. 4. Those who are well suited but prefer not to wear a hearing aid. Unless they have more than a 50 decibel loss in the better ear, it would be justifiable to give them auditory reeducation first and decide later whether they have to wear a hearing device. 5. Those, who through disuse of the poorer ear, exhibit one or more of the disabilities characteristic of monaural hearing.

5 East Sixty-Third Street.

IS IT POSSIBLE TO COVER THE FENESTRA NOV-OVALIS WITH SHRAPNELL'S MEMBRANE?

An Anatomic Study

SAMUEL ROSEN, M.D.
NEW YORK

THE fenestration operation of today is the result of many successive efforts by otologists all over the world. Sourdille [1] created the tympanomeatal plastic flap to seal the widened tympanum and to cover the fenestra. Lempert [2] simplified this step and made the one stage technic at once a more practical and more desirable procedure than the many stage fenestration operation of Sourdille. In Lempert's judgment the covering and sealing of the fenestra with Shrapnell's membrane were of prime importance in the surgical technic, and the success or failure of the operation hinged to a great extent on this. In another paper [3] Lempert reported that osteogenesis occurred when the fenestra was covered with the meatal skin of the tympanomeatal membrane and that it did not occur when the fenestra was covered with Shrapnell's membrane. He came to the conclusion, therefore, that Shrapnell's membrane discouraged osteogenetic closure when it covered the fenestra, because it does not adhere to or nourish the bony fenestral walls.

Later, when describing the fenestra nov-ovalis operation, he explained that the fenestra was now placed over the surgical dome of the vestibule and anterior to its previous situation, over the prominence of the external semicircular canal. Thus the fenestra nov-ovalis was placed anatomically closer to Shrapnell's membrane. Lempert [4] stated:

> The anatomic relationship of position between the fenestra nov-ovalis and Shrapnell's membrane makes the covering of the fenestra with this membrane possible in every case.

From the Department of Otolaryngology, Mount Sinai Hospital.

1. Sourdille, M., cited by Duel, A. B., and others: Otosclerosis: Résumé of Literature from 1928-1935, Ann. Otol., Rhin. & Laryng. **45**:169-281 (May) 1936; New Technique in Surgical Treatment of Severe and Progressive Otosclerosis, Bull. New York Acad. Med. **13**:673-691 (Dec.) 1937.

2. Lempert, J.: Improvement of Hearing in Cases of Otosclerosis: New, One Stage Surgical Technic, Arch. Otolaryng. **28**:42-97 (July) 1938.

3. Lempert, J.: Endaural Fenestration of External Semicircular Canal for Restoration of Hearing in Cases of Otosclerosis: Summary Report of One Hundred and Twenty Cases, Arch. Otolaryng. **31**:711-779 (May) 1940.

4. Lempert, J.: Fenestra Nov-Ovalis: New Oval Window for Improvement of Hearing in Cases of Otosclerosis, Arch. Otolaryng. **34**:880-912 (Nov.) 1941.

This interpretation of the role of Shrapnell's membrane has been questioned by several investigators. In the opinion of Fowler Jr.,[5] Shambaugh[6] and Day[7] it is an anatomic impossibility in most instances for Shrapnell's membrane to reach the fenestra.

The problem of bony closure is one of the most troublesome in fenestration surgery, and one not well understood. For this reason it seems desirable to attempt to resolve disputed anatomic opinions in the hope that a better understanding of the problem will be achieved. These differences regarding the role of Shrapnell's membrane can be explored and demonstrated on operative material.

MATERIALS AND METHODS

The object of this experiment was to measure the distance from the short process of the malleus to the upper limit of Shrapnell's membrane and also that from the short process to the fenestra in a series of cases so as to determine whether or not Shrapnell's membrane could be made to cover the fenestra, and if so, how frequently.

The material used for this study was a series of 50 fresh cadavers on which the fenestration operation was performed. This operation was accomplished as completely and as carefully as if it had been done on the living. Special pains were taken to remove thoroughly the annulus tympanicus above and the pyramidal eminence and the posterior spine below. This procedure insured the greatest possible excursion of the tympanomeatal flap to cover the structures posterior to the tympanum. Before the operation was begun, a fine, sharp-pointed, round needle, the end of which was dipped in green india ink, was thrust through the uppermost portion of Shrapnell's membrane into the tympanum so that the superior surface of the needle could at all times be felt against the bony canal wall. The puncture was virtually at the point where Shrapnell's membrane and the meatal skin meet, and it made possible identification of Shrapnell's membrane in such a manner that when the flap was completed, the green-stained puncture could be seen clearly on both the external and the internal surface of the membrane.

The tympanomeatal flap was thoroughly freed. After the fenestra was made in the surgical dome of the vestibule, the flap was firmly placed, to its limit, over the structures posteriorly in order that it might enclose the widened tympanum and cover the fenestra and the bony structures behind it. Then a large caliber, round, sharp-pointed needle, the tip of which was dipped in black india ink, was thrust through the flap, immediately over the fenestra, so that the needle went directly into the vestibule.

When the flap was raised, the black puncture wound could be seen clearly on its external and internal surfaces. This puncture of the flap over the fenestra was done in each of the 50 cadaver operations. The entire tympanomeatal flap was

5. Fowler, E. P., Jr.: Closure of Operative Fenestrae in Labyrinth, Arch. Otolaryng. **34**:209-224 (Aug.) 1941.

6. Shambaugh, G. E., Jr., and Juers, A. L.: Surgical Treatment of Otosclerosis: Preliminary Report on Improved Fenestration Technic, Arch. Otolaryng. **43**:549-567 (June) 1946.

7. Day, K. M.: Appraisal of Fenestration Operation: Report of One Hundred Cases, Arch. Otolaryng. **44**:547-559 (Nov.) 1946.

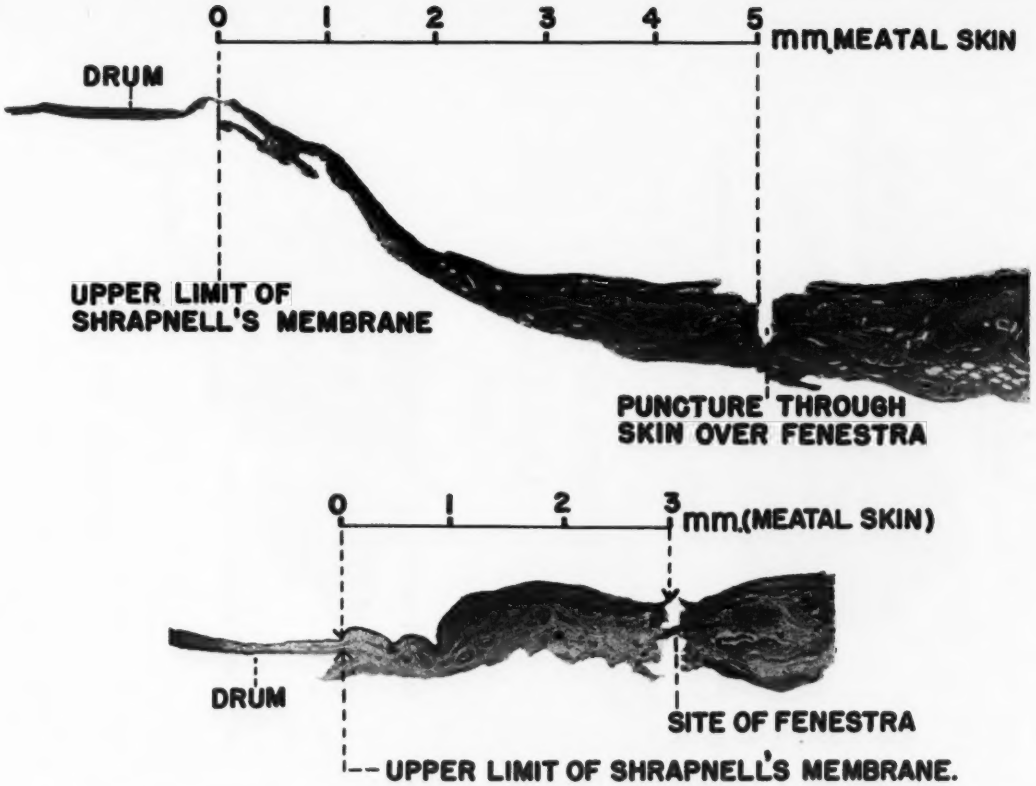
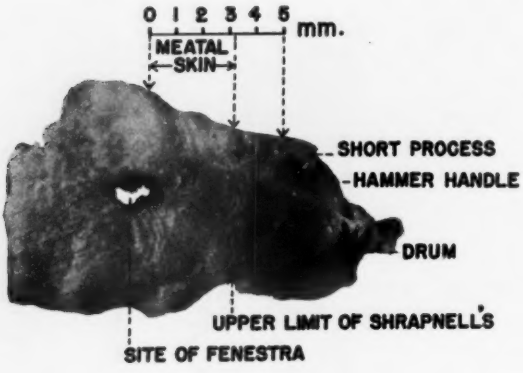
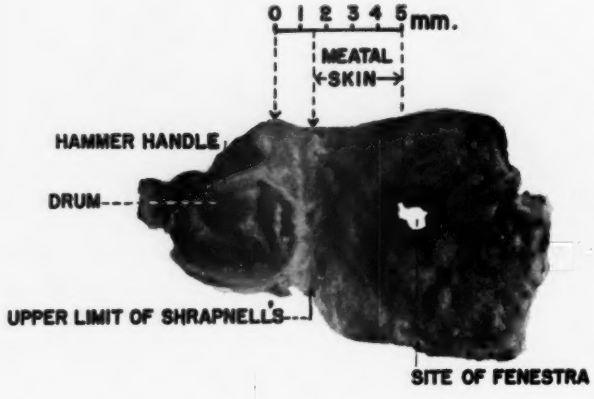

0 1 2 3 4 5 mm. MEATAL SKIN
DRUM
UPPER LIMIT OF SHRAPNELL'S MEMBRANE
PUNCTURE THROUGH SKIN OVER FENESTRA
0 1 2 3 mm. (MEATAL SKIN)
DRUM
SITE OF FENESTRA
UPPER LIMIT OF SHRAPNELL'S MEMBRANE.

Fig. 1.—Histologic sections of 2 specimens showing the puncture wound leading into the fenestra. It may be noted that skin alone covers the fenestra. Shrapnell's membrane can be seen at a considerable distance from the fenestra. Over 15 flaps were sectioned; the findings were similar in each.



EXTERNAL ASPECT



INTERNAL ASPECT

Fig. 2.—Photographs of both surfaces of a tympanomeatal membrane in which the relative position of the short process, Shrapnell's membrane and the puncture wound covering the fenestra may be seen. The distance between the short process and the puncture over the fenestra is too great to permit Shrapnell's membrane to reach the fenestra. Thirty-five of the mastoid bones were large and pneumatic; 10 were moderate in size and diploic and 5 were small and sclerosed.

removed intact and carefully measured. In all cases a measurement was made from the short process of the malleus to the black puncture wound over the fenestra, and in 25 cases, from the short process to the green puncture wound (upper limit of Shrapnell's membrane). All measurements were made in millimeters with the aid of a × 10 optical loupe. This magnification made it possible to measure accurately to a half millimeter. Serial histologic sections of tympanomeatal membranes were made longitudinally through the puncture wound over the fenestra. In this manner the microscopic anatomy anterior and posterior to the puncture over the fenestra could be studied. Photographs of gross specimens were also made.

OBSERVATIONS

The distance from the short process of the malleus to the puncture wound over the fenestra nov-ovalis was measured on 50 specimens, and

Comparative Distance from the Short Process of the Malleus to the Upper Limit of Shrapnell's Membrane and from the Short Process to the Fenestra Nov-ovalis in Fenestrated Fresh Cadaver Specimens

Distance in Mm.	Short Process to Upper Limit of Shrapnell's Membrane, Cases	Short Process to Fenestra Nov-Ovalis, Cases
1.5	10	..
2.0	12	..
2.5	3	..
3.0	..	..
3.5	..	..
4.0	..	..
4.5	..	..
5.0	..	8
5.5	..	14
6.0	..	26
6.5+	..	2
Total	25	50
Average distance	1.8 mm.	5.7 mm.

the distance from the same starting point to the upper limit of Shrapnell's membrane on 25 of the same specimens. The results are shown in the table.

In 10 of the 25 specimens the distance from the short process of the malleus to the green puncture (upper limit of Shrapnell's membrane) was 1.5 mm.; in 12 specimens, 2.0 mm., and in 3 specimens, 2.5 mm. No larger distances were observed. Gray's "Anatomy" [8] and others give the average height of Shrapnell's membrane as 1 to 2 mm. In 26 of the 50 specimens the distance from the short process of the malleus to the black puncture wound, indicating the site of the fenestra, was 6 mm.; in 14 specimens, 5.5 mm.; in 8 specimens, 5.0 mm., and in 2 specimens it was 6.5 mm. or longer.

8. Gray, H.: Anatomy of the Human Body, ed. 29, edited by T. B. Johnston and J. Whillis, New York, Longmans, Green & Co., 1946.

SUMMARY

In 50 fenestration operations performed on fresh cadavers, there was no instance in which Shrapnell's membrane covered the fenestra. Since the distance between the upper limit of Shrapnell's membrane and the short process of the malleus is less than one third of the distance from the short process to the fenestra, it appears most improbable that Shrapnell's membrane can reach the fenestra.

101 East Seventy-Third Street.

HEMANGIOMA OF THE EAR AND MASTOID PROCESS

Report of Two Cases

M. VALENTINE MILLER, M.D.
PHILADELPHIA

MOORE,[1] in his "Textbook of Pathology," described hemangiomas and divided them into three classes: hemartomatous hemangiomas, hemangioblastomas and sclerosing hemangiomas. In writing of the first group he described the pathogenesis as follows:

> . . . If, during development, a small mass of vascular tissue is misplaced or distorted, it may persist as a tumor. With the growth of the body the mass will become evident. Because of stagnation of blood, trauma, or other factors, new vessels form and enlarge the total mass more rapidly than the body as a whole.

He described two types of the hemartomatous hemangiomas: the capillary type, which is made up of numerous small capillaries separated by moderately cellular connective tissue, and the cavernous type, made up of widely dilated channels separated by trabeculae and most often seen in muscle, bone and liver. In the cases reviewed, 3 were reported to be of the last-mentioned type.[2]

The other two types Moore mentioned are rarely, if ever, seen in the ear. In the hemangioblastoma, a true benign neoplasm of endothelium, there is a conspicuous proliferation of endothelial cells, filling the vascular spaces and occasionally invading the surrounding tissue. In some hemartomatous hemangiomas, especially those of the skin and central nervous system, regressive changes may set in without detectable antecedents. The essential alterations in the development of a sclerosing hemangioma are fibrous isolation of capillary segments, accumulation of mononuclear cells filled with fat and deposits of hemosiderin.

REVIEW OF THE LITERATURE

Hemangiomas of the external auditory canal, tympanic membrane, middle ear and mastoid are among the rare tumors found in the ear.

Presented before the Section on Otolaryngology of the College of Physicians of Philadelphia, Nov. 19, 1947.

1. Moore, R. A.: A Textbook of Pathology: Pathologic Anatomy in Its Relation to the Causes, Pathogenesis, and Clinical Manifestations of Disease, Philadelphia, W. B. Saunders Company, 1944.

2. (*a*) Politzer, A.: A Text-Book of the Diseases of the Ear for Students and Practitioners, ed. 5, London, Baillière, Tindall & Cox, 1909, p. 777. (*b*) Buck, A. H., cited by Politzer. (*c*) Mangabeira-Albernaz, P.: Brazil-med. (no. 5) **53**:120-126, 1939.

As a rule they are slow growing and benign, but they may become dangerous because of hemorrhage or pressure of the mass, causing erosion of the surrounding bone and injury to the adjacent structures. Malignant changes can take place in the tumor, but in only 1 case among those reviewed was there apparently any metastasis. This was a case of Bronzini's,[3] reported as an instance of "perithelioma," in which the patient refused operation until three years after he was first seen. A radical mastoidectomy was performed, followed by use of roentgen and radium radiation, but in six months after the operation the cervical nodes were involved, and the patient died about five years after he had been first seen by the physician. The pathologic reports given in the literature cannot be taken at their face value, as hemangioma, angiosarcoma, endothelioma, fibroangioma and certain other terms have been applied by various pathologists to growth probably of the same type of tissue.

Course.—The development of hemangiomas of the ear is usually slow, and the condition may be present for years before the patient calls for medical aid. Occasionally, however, the progress may be very rapid, as is shown by the history in 2 of the cases reviewed, those of the only 2 patients in the series who were under 10 years of age. Both of these cases, because of the rapid progress of the neoplastic process, deserve more attention than will be given other individual cases. The youngest patient whose case was discussed (Calabresi [4]) was a 3 year old boy who four months before admission had found blood on his finger after inserting it into his external auditory canal. This condition was treated locally, but the patient soon complained of headache, insomnia and pain in the mastoid area. There was gradual facial paralysis, and a swelling developed over the mastoid area, but there was no fever. A radical mastoidectomy was performed and the tumor removed. Granulations were removed every three or four days afterward, with severe hemorrhage each time. In spite of everything, the mass developed rapidly, so that an enormous swelling appeared, making the ear seem to be on top of a tumor of the face. The child died one month after operation, the total time between the appearance of the first signs and death apparently having been only five months. There was no autopsy. The pathologist reported that the growth was fibromyxoangioendothelioma.

Sullivan [5] reported a case of a 5 year old girl who had apparently been in good health until about six weeks prior to admission, when

3. Bronzini, A.: Arch. ital. di otol. **40**:590-599, 1929.

4. Calabresi, A.: Osp. maggiore **7**:17-18, 1919.

5. Sullivan, J. A.: Hemangio-Endothelioma of Temporal Bone, Arch. Otolaryng. **20**:61-67 (July) 1934.

she complained of pain in the ear, which persisted and became progressively worse. Three days after the onset the mother noted a mass deep in the external auditory canal. This was removed by a physician, but after its removal it recurred and rapidly enlarged. Facial paralysis developed, and swelling and tenderness appeared over the side of the face. In spite of radical operation and roentgen therapy, the child died with a huge mass in the involved area, about two months after operation. The pathologic report was hemangioendothelioma. Autopsy showed that the mass had invaded the petrosa and had extended to the greater wing of the sphenoid bone anteriorly and the foramen magnum posteriorly. The tumor even had infiltrated downward into the neck and nasopharynx.

Politzer [2a] reported a fatal case of a girl of 12, with a history of illness of eighteen months. This case, with the 2 previously cited, and 5 others,[6] were the only instances reported of death due to the condition among the 55 cases covered by this paper (53 from the literature and 2 reported for the first time here). The ages of the 5 patients at the time of death varied from 21 to 50 years. The condition had been present in most of them for many years before they had consulted an otologist, and they lived up to ten years after such treatment as was possible was instituted.

Age Incidence.—The age incidence of the entire series of patients at the time they were seen by the otologist was as follows: 2 in the first decade of life (the 2 who died so rapidly), 4 in the second, 7 in the third, 9 in the fourth, 9 in the fifth, 10 in the sixth, 5 in the seventh and 3 in the eighth. The age was not stated in 7 cases. The youngest of the group was 3 and the oldest 78 years of age. The women outnumbered the men 38 to 11, a ratio of more than 3:1, for the cases in which the sex was stated.

Site of Origin.—The majority of the reports of cases,[7] including the present 2 cases, gave the location, or probable location, as the

6. (*a*) Fraser, J. S.: J. Laryng. & Otol. **27**:200, 1912; **43**:752, 1928; Proc. Roy. Soc. Med. (Sect. Otol.) **23**:71-77, 1930. Bronzini.[3] (*b*) Specht, F., and Volker: Arch. f. Ohren-, Nasen- u. Kehlkopfh. **120**:93-104, 1929. (*c*) Irgens, E. R.: Hemangioma of Skull Involving Right, Petrous and Occipital Bones, Arch. Otolaryng. **29**:709-712 (April) 1939. (*d*) Mangabeira-Albernaz.[2c]

7. (*a*) Moure, E. J.: Rev. de laryng., Paris **15**:1121-1127, 1895. (*b*) Arslan, Y.: Arch. ital. d otol. **14**:466-470, 1902-1903. (*c*) Beck, J. C.: Illinois M. J. **9**: 137-140, 1906. (*d*) Urbantschitsch, I. E.: Arch. f. Ohrenh. **80**:145, 1909. (*e*) von Hammerschlug, cited by Urbantschitsch.[7d] (*f*) Brady, A. J.: Ann. Otol., Rhin. & Laryng. **21**:787-789, 1912. (*g*) Fraser.[6a] (*h*) Junca, E.: J. de méd. de Bordeaux **43**:595, 1913. (*i*) Calabresi.[4] (*j*) Bronzini.[3] (*k*) Specht and Volker.[6b] (*l*) Jones, J. A.: J. Laryng. & Otol. **45**:265-266, 1930. (*m*) Svartman, J.: Angiome de l'oréille moyenne, Thesis, Paris, Jouve & Cie, 1932. (*n*) Goekoop,

(Footnote continued on next page)

middle ear. One [8] named the middle ear and external canal; one," the middle ear and the petrosa, and another,[10] the middle ear or the petrosa. Two authors,[11] after discussing the rarity of true tumors of the tympanic membrane, each reported a proved case; two [12] reported the drum membrane as the probable site of origin; three others [13] reported the site as the drum membrane, but information I gathered did not prove or disprove the contention; another [14] named the "middle ear, probably the posterior surface of the drum"; one gave the location as the "inner ear or roof of the middle ear"; two [15] reported the petrosa, and one [6c] gave the origin as "the temporal bone." In the last case the skull showed extensive involvement, and it was thought that the dura and the brain were involved; in spite of all this evidence, only the seventh nerve was affected. Only one author [7z] mentioned the external auditory canal as the site of origin. Buck [2b] reported a case of cavernous hemangioma arising from the malleus.

Carrea and Insausti [7x] stated that vascular tumors are the rarest of the uncommon tumors arising in the middle ear; they divided the clinical picture into four stages: (*a*) in the first stage the tumor remains in the tympanic cavity; (*b*) in the second stage it invades the surrounding areas of diminished resistance, usually appearing first in the external auditory canal; (*c*) in the third stage the tumor destroys the petrosa and invades the base of the skull, and (*d*) in the fourth stage the growth of the mass is sufficient to produce intracranial pressure.

C.: Acta oto-laryng. **18**:153-162, 1932; Nederl. tijdschr. v. geneesk. **76**:2679-2681, 1932. (*o*) Busacca, G.: Arch. ital. di otol. **40**:353-369, 1929. (*p*) Bergara, R., and Bergara, C.: Rev. Asoc. méd. argent. **47**:150-156, 1933. (*q*) Caussé, R.: Ann. d'oto-laryng., 1933, pp. 222-224. (*r*) Sullivan.[5] (*s*) Seiffert, A.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **35**:348-351, 1934. (*t*) Barola, A.: Boll. d. mal. d. orrechio, d. gola, d. naso **53**:185-197, 1935. (*u*) McKenzie, W.: J. Laryng. & Otol. **54**:487-492, 1939. (*v*) Mangabeira-Albernaz.[2e] (*w*) Weaver, D. F.: Ann. Otol., Rhin. & Laryng. **52**:507-515, 1943. (*x*) Carrea, R. M. E., and Insausti, T.: Rev. Asoc. méd. argent. **57**:281-286, 1943. (*y*) Capps, F. C. W.: J. Laryng. & Otol. **59**:342-346, 1944. (*z*) Dixon, O. J.: Ann. Otol., Rhin. & Laryng. **54**:415-420, 1945.

8. Piazza, A.: Ann d. mal. de l'oreille, du larynx **42**:178-180, 1923.

9. Haike, H.: Ztschr. f. Laryng., Rhin. **21**:208-213, 1931.

10. Somogyi, I.: Deutsche Ztschr. f. Nervenh. **134**:211-216, 1934.

11. (*a*) Fischer, J.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **5**:22-32, 1923. (*b*) Kepes, P.: Monatschr. f. Ohrenh. **72**:798-808, 1938.

12. (*a*) Jeschek, J.: Monatschr. f. Ohrenh. **70**:1297-1302, 1936. (*b*) Scott, S.: J. Laryng. & Otol. **54**:601-605, 1939.

13. (*a*) Arslan.[7b] (*b*) Layera, J.: Semana méd. **29**:894-897, 1922. (*c*) Richman, F.: Laryngoscope **38**:94-97, 1928.

14. Falk, G.: Acta oto-laryng. **31**:436-443, 1943.

15. (*a*) Politzer.[2a] (*b*) Jack, F. L.: Tr. Am. Otol. Soc. **12**:539-544, 1912.

Presenting Signs.—The first signs are variable. A pulsating tinnitus synchronous with the pulse was reported in 5 cases.[16] Tinnitus without description of the type was reported as characteristic in 10 other cases.[17]

In 8 cases the first sign was a red drum membrane.[18] In 1 of these, Jescheck [12a] noted that the redness increased each month with the menstrual period—the condition in this case, incidentally, was first diagnosed as "grip otitis." One writer [7s] reported "proliferations behind the drum membrane." A number of these red drums were incised, some of them repeatedly, the operation being followed by severe hemorrhage which required packing to control.

Loss of hearing alone was the first sign in 3 cases [19]; loss of hearing with tinnitus, in 6 cases [20]; loss of hearing with pain, in 2 cases [21] and with pain and tinnitus in 1 case,[7p] and loss of hearing with a mass in the external canal or middle ear, in 5 cases [22]; in the one last referred to [17h] tinnitus was also present. In others deafness developed later through the enlargement of the tumor. As might be expected, the original loss of hearing is of the conductive type, but in 15 of the 55 cases covered by this paper involvement of the eighth cranial nerve developed during the course of growth of the tumor.[23]

A polypoid mass was found as an early sign in many of the cases and was often treated as a simple polyp until such treatment produced severe hemorrhages and further studies were made. In a number of cases the mass showed a definite pulsation. This pulsation could occur in a simple aural polyp, developing in the presence of a chronic infection with necrosis of the tegmen tympani, so that dural pulsation would be transmitted to the mass. If pulsation is found, the case requires study before any further treatment is started. One can readily demonstrate the pulsation by placing a cotton-tipped applicator under the mass and allowing the distal end to hang free. Pulsation, if present, will cause

16. Beck.[7e] Svartman.[7m] Bergara and Bergara.[7p] Carrea and Insausti.[7x]

17. (*a*) Urbantschitsch.[7d] (*b*) Fraser.[6a] (*c*) Layera.[13b] (*d*) Goekoop.[7n] (*e*) Busacca.[7o] (*f*) Barola.[7t] (*g*) Scott.[12b] (*h*) Hampton, A. O., and Sampson, D. A.: Am. J. Roentgenol. **41**:25-31, 1939. (*i*) Carrea and Insausti.[7x] (*j*) Falk.[14]

18. Svartman.[7m] Goekoop.[7n] Jeschek.[12a] Scott.[12d] McKenzie.[7u] Capps.[7y] Falk.[14]

19. (*a*) Fowler, E. P.: Laryngoscope **41**:474-478, 1930. (*b*) Haike.[9] (*c*) Capps.[7y]

20. Beck.[7c] Layera.[13b] Busacca.[7o] Scott.[12b] Carrea and Insausti.[7x]

21. Jack.[13b] Capps.[7y]

22. Arslan.[7b] Piazza.[8] Bronzini.[8] Irgens.[6c] Hampton and Sampson.[17h]

23. von Hammerschlug.[7e] Fraser.[6a] Specht and Volker.[6b] Fowler.[19a] Goekoop.[7n] Busacca.[7o] Caussé.[7q] Sullivan.[5] Somogyi.[10] Seiffert.[7s] Irgens.[6c] Mangabeira-Albernaz.[2c]

an up and down excursion of the free end. This fact was beautifully demonstrated in my case reported here.

Bleeding from the ear is a prominent symptom in many cases. It may occur spontaneously or after trauma to the external canal. It is frequently the symptom which forces the patient to the otologist.

Pain may be an early or a late symptom. Of the series under consideration, it was reported to be present in 14 cases: pain in the

*Involvement of Cranial Nerves in Cases of Hemangioma of the Ear and Mastoid Process**

Author Reporting Case	Nerves Involved										Cervical Sympathetic Nerves
	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Beck [7c]	..	..	..	..	+	..	..	..	..	..	..
Politzer [2a]	..	..	..	..	+	..	..	..	..	..	..
von Hammerschlug [7e]	..	..	..	..	+	..	..	..	..	+	..
von Hammerschlug [7e]	..	..	..	..	+	+	..	..	..	+	..
Fraser [6a]	..	..	+	..	+	+	+	+	+	+	+
Calabresi [4]	..	..	..	..	+	..	..	..	..	..	..
Piazze [8]	..	..	..	..	+	..	..	..	..	..	..
Specht and Volker [6b]	..	..	..	..	+	+	..	+	..	..	..
Fowler [19a]	..	..	..	..	..	+	..	+	+	+	+
Goekoop [7n]	..	..	+	..	+	+	+	+	..	..	..
Goekoop [7n]	..	..	+	..	+	+	+	..	..	+	..
Goekoop [7n]	..	..	+	+	+	+	..	..	..	+	..
Busacca [7o]	..	..	..	+	+	+	+	+	+	+	+
Zander [2e]	..	..	..	..	+	..	..	..	..	..	..
Bergara and Bergara [7p]	..	..	..	..	+	+	..	..	..	..	..
Haike [9]	..	..	+	..	+	..	+	..	..	+	..
Caussé [7q]	..	..	..	..	+	+	..	..	..	..	..
Sullivan [5]	..	..	..	..	+	Cochlear only	..	..	..	..	..
Somogyi [10]	+	..	+	+	..	+	+	+	+	+	..
Seiffert [7s]	..	..	..	..	Right	..	..	Left	+	+	..
Barola [7t]	..	..	+	..	+	..	..	..	..	..	..
Irgens [6c]	..	..	..	..	+	..	..	..	..	..	..
Hampton and Sampson [17b]	..	..	+	..	+	+	..	+	..	+	..
Hampton and Sampson [17b]	..	..	+	+	+	+	..	..	..	+	..
Mangabeira-Albernaz [2c]	+	+	..	+	..	..	+	+	+	+	..
Monteiro [20a]	..	..	..	..	+	..	..	..	..	..	..
Carrea and Insausti [7x]	..	..	+	..	+	+	+	+	+	+	..
Dixon [7z]	..	..	..	..	Irritated	..	..	..	..	..	..

* Involvement is indicated by +.

ear in 7 cases,[24] pain in the ear radiating to the shoulder in 1 case,[19a] pain in the ear radiating to the occiput in 1 case,[17b] pain in the mastoid area in 2 cases,[25] pain in the shoulder and neck in 2 cases [7n] and pain in the ear and the entire side of the head in 1 case.[11b]

24. Beck.[7c] Jack.[15b] Fraser.[6a] Bergara and Bergara.[7p] Sullivan.[5] Weaver.[7w] Capps.[7y]

25. Calabresi.[4] Specht and Volker.[6b]

Otorrhea was present in 19 cases.[26] In some of these cases the discharge had been present for a long time prior to the clinical development of the tumor, and then the area had been dry for years; in other cases the discharge had appeared a comparatively short while before the tumor, and in still others the discharge had appeared after and apparently as the result of the tumor. It is possible that the congestion incident to the infection in those cases in which the infection appeared before the clinical development of the tumor played an active part in the further development of a congenitally present nucleus of a hemangioma.

In the 28 reports of cases in the literature in which involvement of cranial nerves was recorded, the first and second nerves were the only ones not mentioned. In 2 cases [27] the third nerve was paralyzed, as was shown by the loss of function of the superior and inferior rectus muscles; in 1 of these [2c] there was also involvement of the fourth nerve, with weakness of the superior oblique muscle. The last-mentioned case was the only one in which that nerve was reported to be involved, and the involvement may have been due to pressure of collections of blood and serum found within the cranial cavity at autopsy. In this case there was a pronounced increase in intracranial tension, with choked disks.

The fifth nerve was involved in 10 cases,[28] as was shown by diminished corneal and conjunctival sensitivity,[7n] pain in the face,[6b] hypogeusia of the anterior two thirds of the tongue [2c] and inability to close the eye.[7t] In the other cases in which this nerve was involved the symptoms were not stated, but just the fact of the involvement was noted.

Involvement of the sixth nerve was present in 5 cases [29] and was demonstrated by paralysis of the external rectus, with convergent strabismus and diplopia.

The seventh nerve, being in the most exposed position, was affected in 25 of the 28 cases with involvement of cranial nerves, paralysis

---

26. (*a*) Moure.[7a] (*b*) Arslan.[7b] (*c*) Buck.[2b] (*d*) Politzer.[2a] (*e*) Jack.[15b] (*f*) Junca.[7h] (*g*) Richman.[13c] (*h*) Specht and Volker.[6b] (*i*) Jones.[7l] (*j*) Svartman.[7m] (*k*) Goekoop.[7n] (*l*) Zander: Internat. Zentralbl. f. Ohrenh. **35**:182-183, 1932. (*m*) Barola.[7t] (*n*) Jeschek.[12a] (*o*) Irgens.[6c] (*p*) Hampton and Sampson.[17h] (*q*) Mangabeira-Albernaz.[2c] (*r*) Carrea and Insausti.[7x] (*s*) Dixon.[7z]

27. Somogyi.[10] Mangabeira-Albernaz.[2c]

28. Fraser.[6a] Goekoop.[7n] Haike.[9] Somogyi.[10] Barola.[7t] Hampton and Sampson.[17h] Carrea and Insausti.[7x]

29. Goekoop.[7n] Busacca.[7o] Somogyi[10] Hampton and Sampson.[17h] Mangabeira-Albernaz.[2c]

being present in all but 1 case,[7s] in which the nerve was reported as "irritated."[30]

The eighth nerve was involved in 15 cases.[31] In 1 of these[5] the cochlear portion alone was affected; in all the others the entire nerve apparently was involved.

The ninth nerve appeared affected in 8 cases,[32] as was shown by difficulty in swallowing and loss of taste in the posterior third of the tongue.

The tenth nerve was involved in 10 cases.[33] Hoarseness was present in 5 of these cases,[34] and paralysis of the soft palate in 4 cases.[35] Reports of the others simply mentioned the involvement of the nerve.

The eleventh nerve was involved in 7 cases,[36] as was shown by the paralysis or weakness of the sternocleidomastoid and trapezius muscles.

The twelfth nerve was involved in 12 cases,[37] as was shown by paralysis of one side of the tongue and difficulty with speech. In 4 cases there was hemiatrophy of the tongue.[38] The twelfth nerve could become involved only if the process had eroded to the petrous tip, with extension of the pressure to the bulbar area or down into the neck.

The cervical sympathetic nerves were reported involved in 3 cases.[39]

In spite of the fact that in 7 of these cases there was involvement of the last four cranial nerves,[40] in only 3 of them[41] could a diagnosis

30. (*a*) Beck.[7c] (*b*) Politzer.[2a] (*c*) von Hammerschlug.[7e] (*d*) Fraser.[6a] (*e*) Junca.[7h] (*f*) Piazza.[8] (*g*) Specht and Volker.[6b] (*h*) Goekoop.[7n] (*i*) Busacca.[7o] (*j*) Zander.[26l] (*k*) Bergara and Bergara.[7p] (*l*) Haike.[9] (*m*) Caussé.[7q] (*n*) Sullivan.[5] (*o*) Seiffert.[7s] (*p*) Barola.[7t] (*q*) Irgens.[6c] (*r*) Hampton and Sampson.[17h] (*s*) Monteiro, A.: Hospital, Rio de Janeiro **23**:271-275, 1943. (*t*) Carrea and Insausti.[7x] (*u*) Dixon.[7s]

31. von Hammerschlug.[7e] Fraser.[6a] Specht and Volker.[6b] Fowler.[19a] Goekoop.[7n] Busacca.[7o] Bergara and Bergara.[7p] Caussé.[7q] Sullivan.[5] Somogyi.[10] Hampton and Sampson.[17h] Carrea and Insausti.[7x]

32. Fraser.[6a] Goekoop.[7n] Busacca.[7o] Haike.[9] Somogyi.[10] Mangabeira-Albernaz.[2c] Carrea and Insausti.[7x]

33. Frazer.[6a] Specht and Volker.[6b] Fowler.[19a] Goekoop.[7n] Busacca.[7o] Somogyi.[10] Seiffert.[7s] Hampton and Sampson.[17h] Mangabeira-Albernaz.[2c] Carrea and Insausti.[7x]

34. Specht and Volker.[6b] Fowler.[19a] Busacca.[7o] Somogyi.[10] Hampton and Sampson.[17h]

35. Fowler.[19a] Goekoop.[7n] Busacca.[7o] Somogyi.[10]

36. Fraser.[6a] Fowler.[19a] Busacca.[7o] Somogyi.[10] Seiffert.[7s] Mangabeira-Albernaz.[2c] Carrea and Insausti.[7x]

37. von Hammerschlug.[7e] Fraser.[6a] Fowler.[19a] Goekoop.[7n] Busacca.[7o] Haike.[9] Somogyi.[10] Seiffert.[7s] Hampton and Sampson.[17h] Mangabeira-Albernaz.[2c] Carrea and Insausti.[7x]

38. von Hammerschlug.[7e] Busacca.[7o] Somogyi.[10]

39. Fraser.[6a] Fowler.[19a] Busacca.[7o]

40. Fraser.[6a] Fowler.[19a] Busacca.[7o] Somogyi.[10] Seiffert.[7s] Mangabeira-Albernaz.[2c] Carrea and Insausti.[7x]

41. Fowler.[19a] Busacca.[7o] Somogyi.[10]

of a jugular foramen syndrome be made from the symptoms reported. The patient in 1 other case showed a beginning jugular foramen syndrome,[78] with weakness of the tongue, vocal cords and sternocleidomastoid and trapezius muscles. This patient died before the disease progressed further, and autopsy showed that the tumor had invaded the lateral sinus and the jugular vein.

Treatment.—There was considerable diversity in the matter of treatment. In 27 cases a radical mastoidectomy was apparently performed, and in 1 case the operation could not be completed because of hemorrhage. The internal and external carotid arteries were ligated in this case. In another the internal carotid artery was ligated because of the bleeding. In 5 cases roentgen radiation was used with radical mastoidectomy, and in 1 case radium radiation was given in addition. In 1 case radium therapy was used after the mastoidectomy. In 2 cases electrocoagulation was done with the mastoidectomy. In 6 cases roentgen radiation alone, and in 3 radium radiation alone, was given. In 2 electrocoagulation and roentgen radiation were used. In 4 cases electrocautery was employed. In only 1 case was the use of a sclerosing fluid reported, but the material used was not stated. One author reported "surgery and the injection of alcohol and fresh lemon juice." In the other reports of cases in the literature either the description of the treatment was vague or the information was not available in the material supplied.

Of the 53 cases from the literature, the result of treatment was available in only 32. In 8 the patients were reported as having recovered; in 6, they were improved; in 2 the hemangioma recurred; in 1 it "recurred and progressed"; in 3 the growth "progressed" and the patient presumably died (these were cases with extensive involvement before the patients were seen by the otologist, and no surgical operation was attempted); 8 patients died because of the condition (2 of these were the 3 year old and 5 year old children reported earlier in this paper, and the others were persons who delayed for years before consulting an otologist); 1 patient died of meningitis; 1 died eight years after operation, of pneumonia; 1 died after an operation for the repair of hernia, and 1 was simply reported as showing "no improvement."

With the patient under proper care, instituted early enough, the prognosis appears to be relatively good except in the cases of tumor developing in early childhood or up to about puberty. Radical mastoidectomy followed by roentgen irradiation I believe offers the best result. I believe in another case I should also give some roentgen treatment prior to operation in an effort to sclerose the mass, at least partially, and to lessen to some extent the troublesome bleeding encountered in operating.

The following cases are presented as additions to the list already reported. Both occurred in the service of Dr. George M. Coates at the Graduate Hospital of the University of Pennsylvania. The first patient was one whom I first saw in the outpatient department and operated on in December 1937, and the other was a private patient of Dr. Coates whom he operated on in March 1945 and whose case he suggested I report with mine.

REPORT OF CASES

CASE 1.—B. M., a 36 year old Negro woman, was admitted to the Graduate Hospital on Nov. 30, 1937. She had had measles as a child but no other childhood diseases. There was no history of tonsillitis or of any aural disorders until February 1936. She said she did not smoke, drink or work. The first trouble with the ear had started in February 1936 with an earache followed by a discharge, on the left side. The patient had been treated in the outpatient department, and when seen in June 1936 she seemed entirely recovered except for some loss of hearing demonstrated by the audiometer but which she could not notice. There was no tinnitus. Apparently there were no other symptoms related to the ear until Nov. 30, 1937, at 2 a. m., when there was spontaneous bleeding from it. The patient ran to the receiving ward, where her ear was packed with cotton and she was referred to the outpatient department. Her blood pressure at that time was 140 systolic and 100 diastolic. She said that there had been no alteration in her hearing, no discharge from the ear, no pain and no tinnitus prior to the onset of the bleeding. When she was seen in the outpatient department, hospitalization was advised, and she was admitted.

On admission her blood pressure was 145 systolic and 90 diastolic. There was no localized tenderness. The right ear showed no abnormality. The left external auditory canal was filled with a large mass, which extended to the external opening of the canal. There was some purulent discharge from about it. The mass pulsated, and an applicator inserted under it moved up and down with each pulse beat. The mass bled readily. There was no tenderness of the mastoid area. The nose and sinuses appeared entirely normal. The tongue was not coated and projected in the midline. Oral hygiene was poor, but the teeth were in fair condition. The tonsils were not large, nor did they appear to be infected. There was no inflammation in the nasopharynx. There was no cervical adenopathy, no abnormal pulsation and no enlargement of the thyroid gland. The rest of the physical examination revealed nothing of significance. Reactions to the Wassermann test and the Kahn test were negative, as was that to the Eagle test. The concentration of hemoglobin was 69 per cent; the white blood cell count, 9,200, with neutrophils 83 per cent (7,636), lymphocytes 16 per cent (1,472) and mononuclear cells 1 per cent (92). The blood was Landsteiner group A. A roentgenologic examination showed no change from the one which had been taken May 13, 1936, which had shown large mastoid processes on both sides; there was a moderate degree of pneumatization on both sides; the sigmoid sinus was not seen distinctly on either side. There was evidence of an old inflammatory process bilaterally. The right mastoid bone was normal at this time. The left mastoid bone showed considerable increased density with appreciable obscuration of cellular detail. There was no definite evidence of destruction of bone, but this possibility was not excluded. The report was by Dr. Karl Kornblum.

With the patient under nitrous oxide–ether anesthesia, I performed an operation on December 3. The operation started at 3:12 p. m. and was not finished until 5:15 p. m. because of the difficulties encountered from the bleeding. A postauricular incision was made, the cortex exposed and the mastoid cells opened. There were considerable necrosis of bone and some pus, the latter particularly in the cells of the tip. There was pronounced softening of the posterior wall of the canal, which had apparently begun to sequestrate, as a piece of it lifted off, exposing the facial nerve for 2 mm. or more. Excessive bleeding was encountered from the mass exposed in the external canal and attached apparently to the inner wall of the middle ear. The area had to be packed off while the removal of bone was extended upward and forward, exposing the middle fossa. The tegmen was eroded. Exposure through the middle fossa was increased so that access to the mass could be gained more readily. The pack over the bleeding mass was removed, and after some difficulty a ligature was thrown around the tumor, which was removed. No ossicles were seen. Once the ligature was about the mass the bleeding was well controlled, but up to that point it was exceedingly troublesome and distinctly slowed the operation. All necrotic bone was removed and the attachment of the tumor well cleaned up, again with troublesome bleeding until the end. The cavity was carefully packed, with due attention to the exposed facial nerve, and when the patient left the table there was definitely no facial weakness. Dr. Case reported the mass as a hemagioendothelioma, and the culture from the mastoid cells showed Corynebacterium diphtheriae.

During the next three days there was a gradual onset of facial paralysis, until by the third day it was complete on the left side in spite of the fact that the packing in the nerve area had been loosened the first day after operation. There was no abnormal bleeding at any of the dressings and, except for involvement of the facial nerve, convalescence was uneventful. The patient was discharged December 18, fourteen days after operation, and told to report to the outpatient department for follow-up observation. She did so for some time, and the ear cleared up. My colleagues and I lost track of her, until about one year later she returned to the outpatient department with a recurrence of the mass and some bleeding. The facial condition was somewhat better.

She was watched carefully, and it was observed that the slightest trauma caused bleeding. The mass was pulsating as before. Surgical intervention was talked of, but we decided to try other measures first. Electrocoagulation was attempted several times, but always with troublesome bleeding and much discomfort to the patient. Use of sclerosing fluids was considered, but I was afraid to try that method, and roentgen irradiation was decided on. The patient had several courses of treatment, the last about one year ago, and she has had no bleeding for almost two years. When she was seen on Oct. 21, 1947, the mass was small and fibrotic. Some pulsation was still noted when an applicator was inserted under it, but there was no bleeding, and the patient said she had had none for about two years. The facial paralysis was considerably less, and she could close her eye and draw the corner of her mouth back, not normally but very well.

CASE 2.—J. L. B., a married white woman aged 61, on March 2, 1938, complained of pain in the right ear of twenty-four hours' duration. The attending otologist stated that the drum membrane was pink around the margin, without bulging. Chronic otorrhea was present at the time. Soon afterward a small red swelling, resembling granulation tissue, appeared at the bottom of the canal adjacent to the drum and coalescent with it. The patient had complained of impaired hearing and tinnitus for ten days previously.

She was first seen by Dr. Coates on July 21. An audiogram taken that day showed a hearing loss for the lower frequencies to far below the useful level on the right side. The right drum membrane was red and slightly bulging in the posterior half; there was some bulging in the external auditory canal. The patient complained of loss of hearing, tinnitus and occasional throbbing pain, with occasional attacks of vertigo. A roentgenogram made the next day showed a sclerotic mastoid bone with no evidence of cavitation. No treatment was administered. When next seen on July 20, 1939 the patient reported that for six months she had had difficulty with articulation. The right tympanic membrane was red and somewhat pushed out. The eustachian tube was patulous. There was no pain, but there was some tenderness about the right ear. A roentgenogram of the larynx and chest revealed a normal condition. On April 5, 1940, the patient's speech had become much worse, asthenic, jerky and spasmodic. At that time the growth had changed little in appearance, but when seen one year later, on April 23, 1941, it had nearly filled the external auditory canal, without causing any further symptoms. The larynx was normal, but the patient was seen at various times by Dr. Gabriel Tucker and Dr. James Sonnett Greene for her speech defect. On July 17 the growth had a slight cystic feel. The patient was seen again on April 24, 1942, and June 23, 1944, when there was little change in her condition.

On Feb. 26, 1945, she was again seen by Dr. Coates and reported that, seven days before, she had had a hemorrhage from the ear at night, and again after manipulation by the attending otologist in Harrisburg. The bleeding had lasted two hours and had been followed by slight oozing for several days. Partial paralysis of the facial nerve was noted for the first time. A roentgenogram taken on March 14 showed nothing new, except a small erosion cavity of the posterior bony wall of the canal. The patient was admitted to the Graduate Hospital on March 19, and a specimen for biopsy was taken with a high frequency cutting loop. The pathologic report was "benign polyp." On March 24 a radical mastoidectomy was done by Dr. Coates. The mastoid cells were observed to be denuded of mucous membrane, and there was some necrosis of bone. The facial nerve was found pathologically exposed. A large mass of friable, bleeding tissue filled the middle ear, with erosion of the posterior wall of the canal. The bleeding made completion of the operation difficult. The facial paralysis was severer after the operation, probably because of pressure from the packing, which was removed the fourth day. The mastoid wound healed nicely, with early epidermatization. The pathologist (Dr. Eugene Case) reported hemangioendothelioma. There was a small recurrence of the growth later, but a recent examination showed that it had remained stationary. Her facial paralysis and voice defect remained unchanged. Dr. Tucker said that he considered the voice defect a functional condition. Though at one time the patient had had leukoplakia of the right cord, this had cleared up entirely, without benefit to the speech.

114 West Phil-Ellena Street.

CLINICAL AND PATHOLOGIC AURAL FINDINGS IN A CASE OF CARCINOMATOSIS OF THE MENINGES

EUGEN GRABSCHEID, M.D.
NEW YORK

REPORTS of carcinomatosis of the meninges since Saenger's [1] first publication in 1900 have been few. Although the condition occurs more frequently than the few reports would indicate, the number of reports including the pathologic changes occurring in the ear in this disease have been fewer (Schlittler,[2] Wagener,[3] Mayer,[4] Hellmann,[5] Brunner,[6] Barth,[7] Meller [8]). In the case which is described later the ears revealed many clinical and pathologic changes.

Carcinomatosis of the meninges is characterized clinically by symptoms of meningeal irritation and eventually by increase of intracranial pressure, followed by simultaneous appearance of symptoms of involvement of the cranial nerves and the spinal cord.

There is a dense accumulation of tumor cells in the subarachnoid space. The cells follow the flow of the cerebral spinal fluid and reach the subarachnoid sheaths of the cranial and spinal nerves. At the points where the nerves penetrate the dura there is a narrowing of the sheaths causing the cancerous cells to congregate, probably owing to the stag-

---

From the former Ear, Nose and Throat Department of Docent H. Brunner at the Allgemeine Policlinic of Vienna.

1. Saenger, A: Ueber Hirnsymptome bei Carcinomatose, Neurol. Zentralbl., 1901, p. 1086.

2. Schlittler, E.: Ueber das metastatische Karzinom des Gehörorgans und über dessen Beziehungen zur Meningitis carzinomatosa, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **103**:121, 1919; Ueber Meningitis carcinomatosa, Schweiz. med. Wchnschr. **56**:763, 1926.

3. Wagener, O: Zur Pathologie des Ohres bei Meningitis carcinomatosa, Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres **14**:83, 1920.

4. Mayer, O.: Metastatisches Karzinom des Gehörorgans, Monatsschr. f. Ohrenh. **56**:541, 1922.

5. Hellmann, K.: Zur Lehre vom metastatischen Carcinom des Hörnerven, Ztschr. f. Hals-, Nasen- u. Ohrenh. **4**:157, 1922-1923.

6. Brunner, H.: Beiträge zur otologischen Diagnostik der Hirntumoren: Das verhalten des Schlafebeines bei Hirncysticercose und bei Meningitis carcinomatosa, Monatsschr. f. Ohrenh. **68**:257, 1934; Case of Carcinomatosis of the Meninges, Ann. Otol., Rhin. & Laryng. **50**:910, 1941.

7. Barth, H.: Ueber Carcinommetastasen im Felsenbein, Ztschr. f. Hals-, Nasen- u. Ohrenh. **37**:181, 1935.

8. Meller, H.: Zur Frage der Meningitis carcinomatosa des Schlafenbeines, Wien. klin. Wchnschr. **52**:114, 1939.

nation of the cerebral spinal fluid at these points. The accumulated cells cause a bulging of the nerve sheaths above these points.

REPORT OF CASE

C. F., aged 52, white, a housewife, stated that she had always been healthy. In the beginning of October 1937 she fell backward from a height of 4 feet (about 1 meter). She did not lose consciousness and suffered no ill effects. On October 31 she had a severe occipital headache, accompanied by emesis and vertigo, but no visual disturbances. She noticed, however, variation in her auditory acuity; at one time hearing would be acute, and at other times she was unable to hear though spoken to from a point close to her ear. These complaints continued unabated, and she was admitted to the hospital on November 16.

Her family history revealed that her mother had died of carcinoma, but she could not specify its exact nature.

Neurologic Findings.—Head: There were tenderness of the occiput on palpation and distinct and diffuse pain on percussion, particularly over the left side of the occiput, which caused the patient to wince. An attempt to turn the head to the extreme left caused severe pain in her neck.

The pupils were of medium size, equal, regular, and reacted well to light and accommodation. Slight weakness of the lower part of the left side of the face was also present.

Eyes: There was weakness of upward and downward gaze, while on lateral gaze the eyes reached the end position but could not be held there. When looking sideward the eyes revealed a horizontal rotatory nystagmus in the end position, bilaterally; while looking upward they showed a few diagonal oscillations to the right; while looking downward they revealed rotatory nystagmus. There was skew deviation of the eyes. The visual fields showed no abnormalities.

There was a choking of the disk of 2 diopters on the right side, and the veins were enlarged on the left side. Diplopia was not evident. The right corneal reflex was slightly diminished; the left was normal.

Ears: The ear drums were retracted on both sides. The low intelligence of the patient did not permit accurate results to be obtained with the tuning forks. Repeated examination showed variation of the acuity of hearing. One day the patient did not hear conversational voice close to her ear, and on another day she was able to hear well from a distance of 10 feet (3 meters). The caloric test yielded normal irritability on the right side and diminished irritability on the left side.

Upper Extremities: There was no paresis, no atrophy, no ataxia with the finger to nose test. The deep reflexes were active and equal. No changes of sensibility were recorded. The tendency toward pronation was more pronounced in the right arm than in the left. The rebound phenomenon was present on both sides, and further examination revealed disturbed stereognosis on the right side.

Lower Extremities: On standing without support the patient swayed and tended to fall to the left and backward. Although reluctant to start walking, after she had overcome this reluctance her gait was clear. She walked stiffly and deviated to the left side, taking small steps and not lifting her feet from the ground. Her arms did not move but were held stiffly in adduction.

Internal Examination.—The roentgen examination of the head, the chest and the gastrointestinal tract revealed no pathologic changes. The Wassermann

reaction of the blood was negative, and examination of the blood showed hypochromic anemia and an accelerated sedimentation rate.

On November 19 a ventriculographic examination failed to reveal any abnormal condition. The cerebrospinal fluid findings were: slight increase of protein, no increase of cells, no presence of epithelial cells.

The clinical diagnosis of cerebral tumor was made, but as the patient showed signs of rapid weakening, an operation was not performed. The patient died on December 9.

Fig. 1.—Cross section of the cerebellopontile angle. *P1* is the choroid plexus; *VIII*, the eighth nerve, covered and infiltrated by carcinoma cells (*a*).

In the calvaria, at autopsy, there was an opening 6 mm. in diameter on each side; the dura was well stretched and the large sinuses were free. The leptomeninges of both occipital lobes were slightly infiltrated with blood; the gyri were enlarged and flattened and the sulci narrow. Above the cerebellum and toward the right the leptomeninges were completely filled with small yellow-white spots. In the right cerebellopontile angle the consistency of the brain substance was harder than that on the corresponding left side. The brain was put into 4 per cent formaldehyde solution without being sectioned. Micro-

scopically, in frozen sections of the leptomeninges above the cerebellum there was carcinomatosis. Chronic pulmonary emphysema and a hypertrophied and dilated right cardiac ventricle were found. On examination of the lymph nodes in the right supraclavicular fossa a hard lymph node was found, in which a myxomatous carcinoma was revealed by microscopic examination. After careful dissection of both mammae, many slides from each were examined histologically, but in none was carcinoma found. A careful examination of the bronchi and the lungs revealed

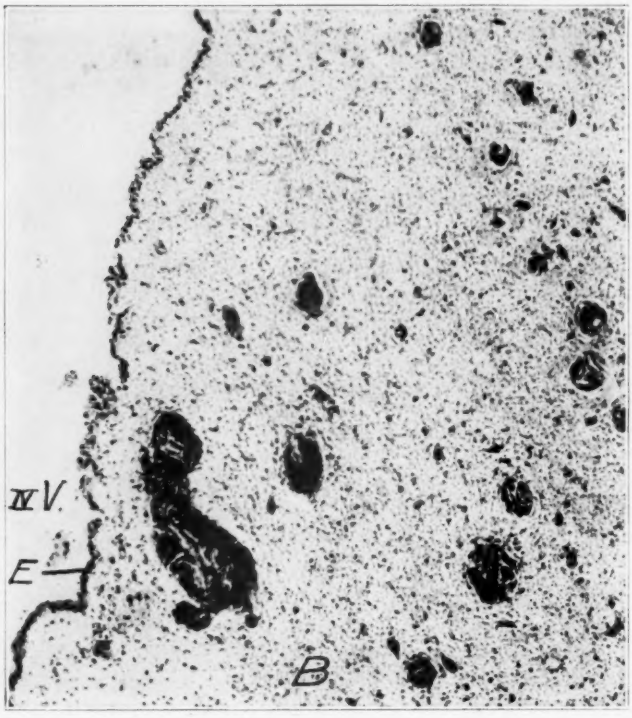


Fig. 2.—Area of Bechterew's nucleus (*B*) with several metastases of carcinoma. *IV V.* is the fourth ventricle; *E*, ependyma.

no pathologic involvement, and a button-like, hardly visible thickening of the mucosa of the stomach proved to be noncancerous on microscopic examination.

Microscopic Description.—Cerebrum: On a few frontal sections of the brain fixed in formaldehyde solution, numerous hemorrhagic foci, ranging in size up to that of a cherry, were found in both cerebral hemispheres. The whole cerebrum was full of secondary carcinoma.

Medulla: On examination of a complete series of cross sections of the medulla oblongata prepared by Nissl's method, an extensive infiltration of the

leptomeninges was found, especially pronounced in the angle between the medulla oblongata and the cerebellum. Here the cranial nerves were ensheathed with carcinoma cells. In addition, the carcinoma cells were seen to be invading the stem of the acoustic nerve (fig. 1). The conditions were of equal intensity on the two sides. The ventral cochlear nucleus was apparently not involved, but in the rest of the medulla oblongata there was an accumulation of carcinoma cells around the blood vessels (fig. 2). This was likewise pronounced in the vermis of the cerebellum.

Temporal Bones: Left Side: The eustachian tube was patent; the mucous membrane at the floor of the tube showed hyaline degeneration. At some points

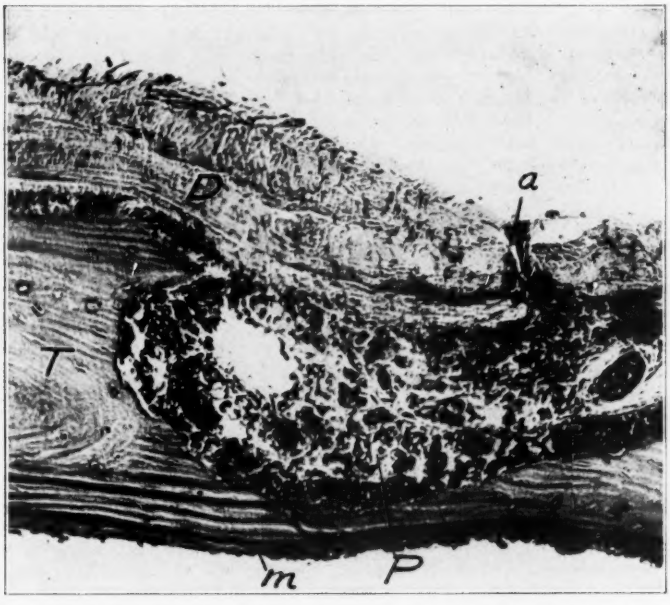


Fig. 3.—Cross section of the tegmen tympani (*T*) with pacchionian granulations (*P*). *D* is the dura; *M*, the tympanic mucosa; *a*, a channel in the dura allowing herniation of the arachnoid. Note the carcinoma cells within the pacchionian granulations.

the hyalin was deposited in clusters and platelets, which at some places were so numerous that the mucous membrane became uneven. The bony walls showed deposition of osteoid substance at several points. The epithelium of the tube was low, while the epithelium of the middle ear was high. The tegmen and the hypotympanum were highly pneumatized. The pneumatization also extended deep into the anterior part of the lateral attic wall so that the greater part of the drum membrane inserted on the thin wall of a pneumatic cell. For this reason the membrane was not stretched but showed folds. Malleus, incus and stapes were normal. Shrapnell's membrane bulged outward considerably. Prussak's space

was enlarged and the antrum was wide. A large vein originating in the jugular bulb ran through the posterior wall of the bulb and entered the dura of the posterior fossa of the brain.

The windows were normal. In the region of the tube and in the tegmen tympani there were many pacchionian granulations which contained numerous cancer cells and dug deep fossae into the bone (fig. 3). The internal meatus was slightly enlarged, and its upper and posterior walls showed numerous lacunas without osteoclasts. The bone of the internal meatus was absorbed by engorged veins which paralleled the bone in long rows and absorbed the bone by means of endothelial cells.

All the nerves of the inner auditory canal were infiltrated with cancer cells (fig. 4). The cancer cells invaded the connective tissue part of the nerve, distal to the Alexander-Obersteiner glia-septum, whereas the proximal part of the acoustic nerve remained unaffected. The cancer cells invaded the connective tissue of the nerve and became more and more numerous in the region of the fundus of the internal auditory canal, where they destroyed the cochlear nerve completely and invaded the modiolus along the blood vessels (fig. 5). The vestibular ganglion had disappeared. The cancer cells likewise invaded the glossopharyngeal nerve and the petrosal ganglion.

The cancer consisted of large cells with well developed, eosin-staining protoplasm and vesicular, eccentrically situated nuclei. The cells were polygonal when they were in rows between the nerve fibers and round when they were free in the tissue. Often they formed glandular-like tubes without secretion. Quite often there were giant cells with two or more nuclei. Finally there were large and small foci of necrosis among the cancer cells.

In the tractus spiralis foraminosus the cancer cells could be recognized only with great difficulty, because the periosteal connective tissue was much thickened and hyalin degenerated, causing compression and degeneration of the cancer cells. Cancer cells were also found in Rosenthal's canal. Here they completely replaced the spiral ganglion, especially in the basal coil, and entered the spiral nerve, but they never appeared among the two tables of the spiral lamina (fig. 6). Occasionally in the spiral ganglion of the middle and the top turn, cancer cells were found.

The cancer cells penetrated farther into all branches of the vestibular nerve. In the region of the saccular nerve they could be followed until the macula cribrosa was reached, but there were no cancer cells in the macula of the saccule. In the region of the utricle the cells did not extend to the macula cribrosa, so that of all the sensorial organs of the labyrinth, the utricle was best provided with nerves. The cancer cells invaded the foramens of the macula cribrosa of all three cristae ampullares without causing a thickening of the periosteum of these channels. Cancer cells could likewise be found in the connective tissue of all three cristae.

In all spaces of the internal ear there was a cell-free fluid which stained with eosin and must be considered as a transudate. All capillaries of the inner ear were engorged. In the macula sacculi there was a fresh hemorrhage, likewise in the vestibule and the scala tympani and in the cochlear aqueduct. In the inferior utricular recess there was an atypical epithelial spot. There were artificial changes of Corti's organ. Only the pillar cells were well preserved. The stria vascularis was normal and had here and there cells rich in protoplasm close to the capillaries. The question whether these cells were cancer cells could not be answered. Corti's membrane was adherent to Corti's organ and the latter to Reissner's membrane, so that the duct filled with serous fluid was markedly narrowed. In between the

spiral laminas there were a few degenerated nerve fibers. The pigment content of the cochlea was normal. The cochlear aqueduct was free. In the region of its cerebral opening there were several pacchionian granulations infiltrated with

Fig. 4.—Section through the facial nerve (*F*) and the cochlear nerve (*C*) in the internal auditory meatus (*Mai*). *a* indicates the zone of Alexander-Obersteiner. Note the infiltration of the cochlear and facial nerve with carcinoma cells.

cancer cells. From the internal meatus the cancerous infiltration extended into the facial nerve and could be followed up to the geniculate ganglion. In the horizontal portion of the facial nerve a remarkable reduction of the number of nerve fibers was noted, but no cancerous infiltration. The chorda tympani and the tympanic (Jacobson's) nerve were normal.

Right Side: The tube, the antrum and the middle ear were large. There was pronounced pneumatization of the tegmen and normal insertion of the slightly

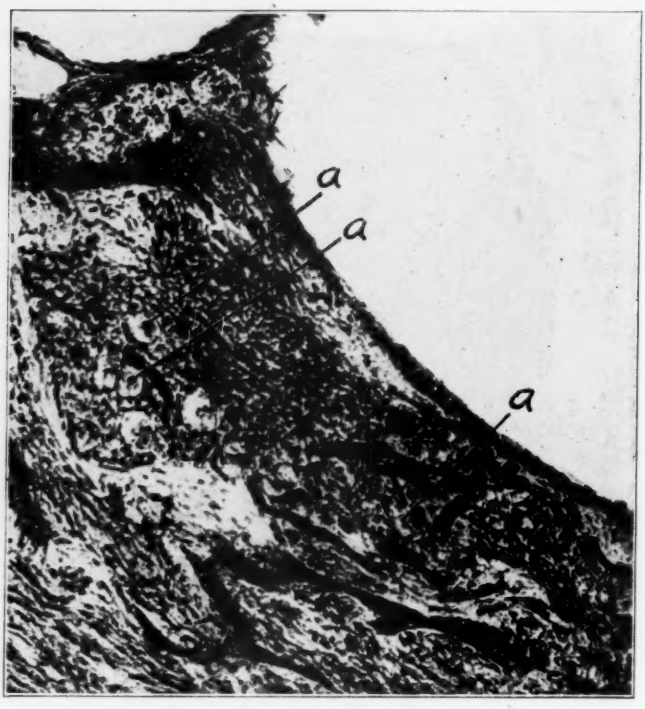


Fig. 5.—Section through the modiolus; *a* indicates carcinoma cell.

atrophic drum membrane. Malleus, incus and stapes were normal. The superior petrosal sinus was thrombosed, and its walls were infiltrated with cancer cells. The internal auditory canal was slightly enlarged. Resorption was caused by veins but not by Pacchioni's granulations. All nerves of the internal auditory meatus were infiltrated by cancer cells. Carcinoma cells and corpora amylacea were found in the glial parts of the acoustic nerve. The inner ear had undergone the same changes as that of the left side. The modiolus showed a few more ganglion cells than that of the left. The transudate was more abundant.

In conclusion, the same changes took place on both sides, namely: 1. The walls of the internal auditory canal had been resorbed by endothelial cells of the veins and by Pacchioni's granulations, which contained cancer cells. 2. Cancerous infiltration had involved all nerves of the internal auditory meatus. 3. The vestibular ganglion was missing on the left. The geniculate ganglion remained free. 4. The spiral ganglion in the region of the basal coil was entirely replaced by cancer cells. Here and there cancer cells were also found in the spiral nerves of the basal, middle and top coils of the cochlea. 5. The cancer cells extended through the holes of the macula cribrosa of all three cristae ampullares and invaded the

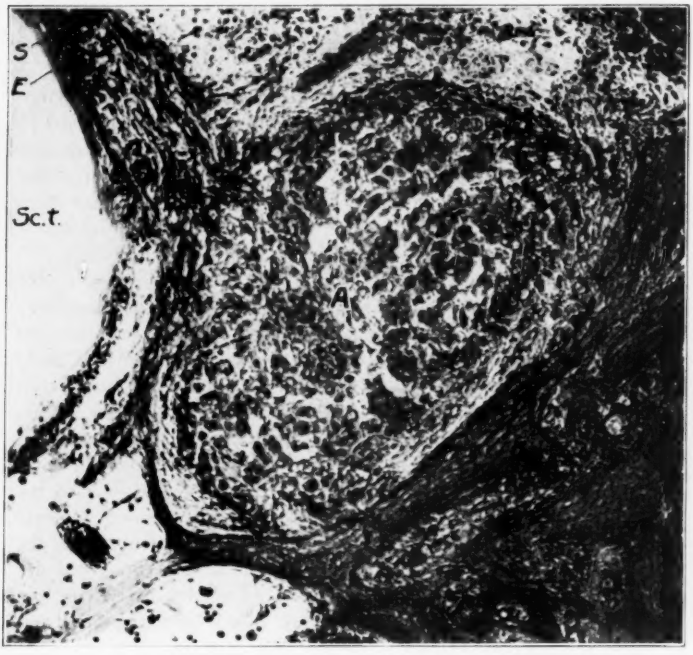


Fig. 6.—Cross section of the spiral ganglion of the upper portion of the basilar coil (*A*) showing carcinoma cell infiltration. *Sc.t.* is the scala tympani; *E*, exudate; *S*, the spiral nerve.

connective tissue of all three cristae. 6. Fresh hemorrhages were present in the macula sacculi, the scala tympani and the aqueductus cochleae. 7. There was a transudate in the cochlea, the vestibule and the labyrinth. 8. The sensorial organs were not invaded.

COMMENT

Carcinomatosis of the meninges is invariably caused by metastasis. It is interesting to note that not infrequently in cases of carcinomatosis

the primary tumor cannot be discovered, not even at autopsy. This happened in the presented case, although a diligent search was made. The pathologic aspect consists of an infiltration of the meninges with carcinoma cells. The brain substance may or may not be involved. In the presented case a perivascular carcinoma cell infiltration was found in the medulla oblongata and in the cerebellum.

It was Schlittler [2] who in 1919 drew attention to the changes within the ear caused by carcinomatosis of the meninges. The findings consist essentially in an infiltration of the acoustic and facial nerves. The highest degree of infiltration was found in the cochlear nerve, parts of which were destroyed by the carcinoma cells. The central (glial) portion of the cochlear nerve did not contain carcinoma cells, although at its exit from the medulla oblongata the nerve was ensheathed by large masses of carcinoma cells. In contradistinction to the central portion, the distal portion of the cochlear nerve contained numerous carcinoma cells, which accumulated partially in front of the tractus foraminosus. This peculiar distribution of the carcinoma cells indicates that there is no proliferation of carcinoma cells from the medulla to the fundus of the internal auditory meatus. One must assume rather that there is a transportation of carcinoma cells from the medulla oblongata to the internal meatus, the tractus foraminosus acting as a barrier which permits only a few cells to pass into the modiolus, into the spiral ganglion and eventually even into the basilar portion of the spiral nerve. It is likely that the same mechanism is acting in the distribution of carcinoma cells along the branches of the vestibular nerve, where the respective macula cribrosa acts as a barrier, and along the facial nerve, where the geniculate ganglion inhibits further progress of the carcinoma cells. In other words, there is a fluid flowing from the meningeal spaces toward the inner ear. The fluid conveys carcinoma cells and lays them down where it meets with an obstacle. From this concept one must not draw the conclusion that a centrifugal flow of this type is likewise present under physiologic conditions. This conclusion would not be correct, because carcinoma cells may be carried within lymph vessels by retrograde transportation even in the presence of valves.

The accumulated carcinoma cells exercise a destructive influence on the nerves and the ganglion cells within the internal ear and, in addition, cause passive hyperemia by compressing the veins of the internal ear. This results in destruction of great parts of the acoustic nerve, of the spiral ganglion and eventually of the vestibular ganglion and in accumulation of a transudate within the inner ear. The latter finding is called "stagnation hydrops of the internal ear" (Brunner [6]; Fischer [9]).

9. Fischer, J.: Changes in the Internal Ear Due to Increased Endocranial Pressure, Arch. Otolaryng. **31**:391 (March) 1940.

The pathologic observations explain to a certain extent the otologic observations, which are not uniform. Some of these patients show a slight degree, others a high degree, of deafness; some show a normal, others a subnormal or even an absence, of labyrinthine excitability. All depends on the degree of nerve destruction caused by the carcinoma cells. In the presented case the labyrinthine excitability was normal on the right side and slightly diminished on the left side. Correspondingly, the branches of the vestibular nerve showed only slight destruction. The hearing was markedly diminished, but the acuity of hearing varied. This was noticed by the patient as well as by me. It is likely that the oscillations of the acuity of hearing were caused by the stagnation hydrops of the internal ear, the degree of which is proportional to the pressure exercised by the carcinoma cells on the veins of the internal ear. Since this pressure varies according to the amount of accumulated carcinoma cells, the stagnation hydrops likewise must show fluctuation of its intensity. In fact, in some cases of carcinomatosis of the meninges no stagnation hydrops was observed, although carcinoma cells had invaded the internal meatus. It is possible that the fluctuations of the intensity of the stagnation hydrops correspond with the fluctuations of the acuity of hearing in the presented case.

2099 Lexington Avenue.

SQUAMOSITIS, MASTOIDITIS AND SQUAMOMASTOIDITIS

DOMINICK A. DeLISA, M.D.
SCHENECTADY, N. Y.

KÖRNER [1] published his report on "the septum petrosquamosum and its clinical significance" in 1927. Wolff [2] had previously called it the "septum mastoideum," and others,[3] including Körner, had described it earlier without naming it. It is now commonly called Körner's septum. Körner demonstrated the existence of two pneumatic cell systems of the mastoid process, separated by the petrosquamous septum. Their only intercommunication is via the antrum tympanicum, into which each cell system leads. The petrosquamous septum is formed in childhood by the fusion of the apposing cortical surfaces of the mastoid portions of the pars petrosa and of the pars squamosa in the formation of the mastoid process. Körner pointed out that either or both bones, with their contained independent cell systems, can be diseased in clinical mastoiditis. In the American literature the essential points made by Körner are contained in Batson's [4] excellent monograph on the surgical anatomy of the temporal bone.

STATEMENT OF PURPOSE

The current nomenclature, methods of clinical and roentgenologic diagnosis and surgical treatment of mastoid disease have been little changed by Körner's observations. The clinical signs and roentgen findings depend on whether one or the other or both cell systems

Read before the Philadelphia Laryngological Society, April 6, 1948.

1. Körner, O.: Die Grenzen zwischen den pneumatischen Zellensystemen des Antrum petrosum und des Antrum squamosum beim Erwachsenen, Ztschr. f. Hals-, Nasen- u. Ohrenh. **5**:425, 1923; Das Septum petro-squamosum (mastoideum) und seine klinische Bedeutung, ibid. **17**:137, 1927.

2. Wolff, H. I.: Die klinische Bedeutung des Septum mastoideum und der durch dasselbe getrennten Cellulae squamosae und petrosae des Warzenfortsätzes, Acta oto-laryng. **9**:254, 1926.

3. Brühl, G.: Schläfenbein mit Dehiscenz des Proc. mastoideus, des Sulcus sigmoideus und einem Bulbus superior, Monatschr. f. Ohrenh. **46**:275, 1912. Frey, H.: Ein Beitrag zur Anatomie des Schläfenbeines, Arch. f. Ohrenh. **68**:44, 1906. Kirchner, W.: Ueber das Vorkommen der Fissura mastoidea squamosa und deren praktische Bedeutung, ibid. **14**:190, 187.

4. Batson, O. V.: Surgical Anatomy of the Temporal Bone, in Nelson's Loose-Leaf Surgery of the Ear, New York, Thos. Nelson & Sons, 1947, p. 127.

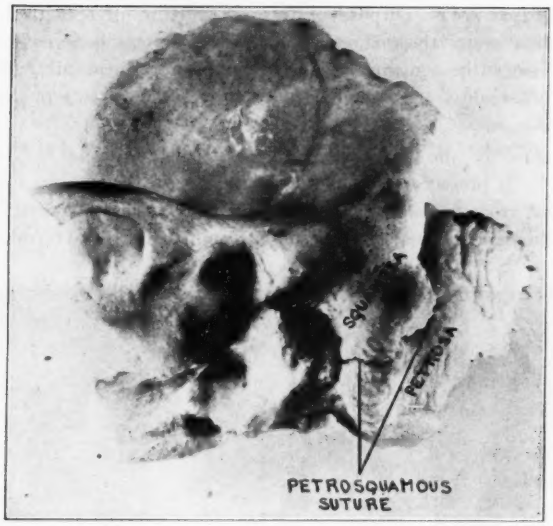


Fig. 1.—Left temporal bone of 12 year old boy, showing the petrosquamous suture between the pars squamosa and the pars petrosa. (Specimen loaned by W. F. Whelan, M.D., Philadelphia.)

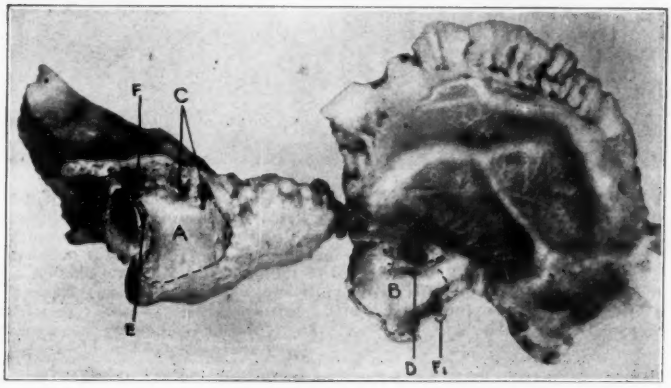


Fig. 2 (same specimen as in fig. 1).—The pars squamosa and the pars petrosa have been disarticulated, and the pars squamosa laid back to the right, to reveal its medial surface. *A*, the petrosal portion of the petrosquamous septum; *B*, the squamosal portion of the petrosquamous septum; *C*, the petrosal antrum; *D*, the squamosal antrum; *E*, the posterior-superior border of the tympanic plate; *F* and F_1, articulating edges of the pars petrosa and the pars squamosa within the bony external auditory meatus, which are not covered over by the tympanic plate.

are diseased. The purpose of this paper is to present the clinical differentiation of these three possibilities. This is believed to be in order, since the existing practice of including them all under the term "mastoiditis" is paradoxic and may result in errors of diagnosis and treatment.

Disease of the pars squamosa lies largely outside the mastoid process. It presents a clinical picture and roentgen findings markedly different from disease of the mastoid process, and it requires special adaptations of the conventional surgical approach. It is not mastoiditis

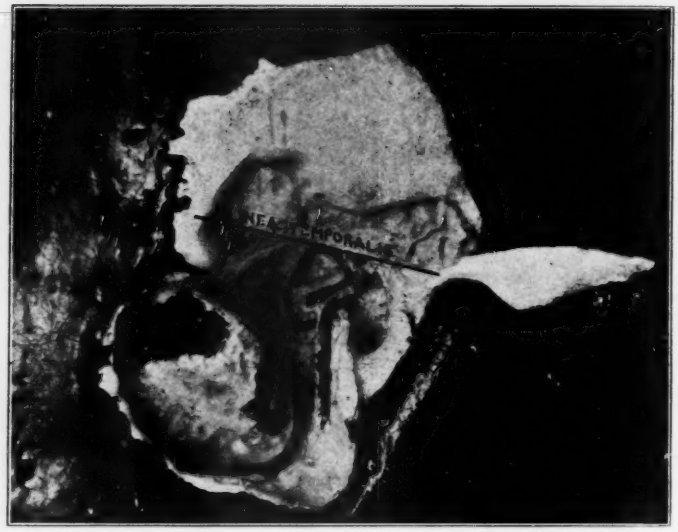


Fig. 3.—Right temporal bone. The exenterated cellular area extends well above the linea temporalis and anterior to the external auditory meatus. The superior wall of the external auditory meatus has been removed. The region between the superior canal wall and the floor of the middle cranial fossa was highly pneumatic. This specimen illustrates pneumatization of the pars squamosa extending beyond the confines of the mastoid process, which is limited above by the linea temporalis and anteriorly by the posterior wall of the external auditory meatus. (Specimen prepared by the author.)

but squamositis. Disease of the pneumatic cells of the temporal bone, exclusive of the petrous pyramid, may be classified as follows: (1) mastoiditis—disease of the petromastoid cell system and mastoid base of the petrous bone; (2) squamositis—disease of the squamosal cell system and squamous bone; (3) squamomastoiditis—disease of both cell systems and both bones.

CLINICAL SIGNS

In mastoiditis the cardinal points of tenderness are over the antrum tympanicum, the mastoid tip and the emissary vein. In squamositis tenderness is found in the supra-auricular region. Loss of motility of the skin due to slight edema is postauricular in mastoiditis; in squamositis it is supra-auricular or preauricular. Obliteration of creases of the skin is postauricular in mastoiditis; in squamositis it is supra-auricular. In mastoiditis displacement of the auricle is away from the head and forward; in squamositis it is away from the head and downward.

A small furuncle-like lesion with a draining apex in the posterior-superior wall of the external auditory canal, close to the drumhead, is an occasional finding in squamositis. The anatomic basis of this lesion is the subcutaneous situation at this point of the innermost portion of the petrosquamous suture. The meatal part of this suture is closed by the tympanic plate of bone except immediately external to the drumhead. The furuncle-like lesion results when the suppurative process extends through this portion of the suture. This lesion is frequently considered a local cutaneous lesion, and the adjacent pathologic change in the bone is overlooked. Sagging of the posterior-superior canal wall is present when perforation of the skin does not occur.

Squamomastoiditis produces any combination of the aforementioned clinical signs.

ROENTGEN FINDINGS

Radiologists are almost universally unaware of the important observations made by Körner and others. Roentgen changes due to involvement of the squamosal cells without disease of the petromastoid cell system are seldom correctly interpreted. The lateromedial depth of the cellular extensions between the outer and inner tables of the pars squamosa is but a small fraction of the depth of the cellular area in the mastoid process. The change in radiolucency caused by suppuration in cells above the linea temporalis is correspondingly less and is easily overlooked. Definite evidence of squamositis is often reported simply as clouding of the region of the antrum.

SURGICAL CONSIDERATIONS

The accepted technics of simple and radical mastoidectomy do not remove diseased bone in the well pneumatized pars squamosa. After the mastoid cavity has been exenterated, temporal bones of this type require removal of the outer table of the pars squamosa above the linea temporalis and in an anterior direction to the limits of cellular extension. If the original incision is postauricular, it must be prolonged

upward and forward, in many cases beyond the anterior attachment of the auricle. The bony superior canal wall is frequently several millimeters from the floor of the middle cranial fossa, and the intervening region may be occupied by diseased cells. In this region adequate exenteration necessitates that the skin of the external auditory meatus be retracted downward and the bony superior canal wall removed in order to afford access. If preservation of the ossicular chain of the middle ear is intended, the innermost portion of the scutum of Leidy with its attached membrana tympani is left intact. However, the lateral wall of the epitympanum should be removed. This can be accomplished without dislodging the ossicles. When the pars squamosa, as well as the mastoid process, is exposed, the procedure is correctly called squamomastoidectomy. In mastoidectomy performed in the presence of

Fig. 4.—Roentgenograms of the mastoid processes. The left (in the right circle) is normal. The right demonstrates clouding and destruction of cells of the pars squamosa. The cells of the mastoid portion of the pars petrosa are slightly clouded but otherwise normal. The pathologic condition cannot be called mastoiditis, since the mastoid process is practically normal. The pathologic involvement is in the pars squamosa and can properly be termed squamositis.

squamositis, neglect of the pars squamosa can lead to continued aural discharge and even petrositis or intracranial complications. In only a small percentage of cases do the anatomic limits of the mastoid process represent the limits of pneumatization and disease. Therefore squamomastoidectomy is the indicated conservative operation in most cases of so-called mastoiditis.

SUMMARY

The primary purpose of this paper is to emphasize the existence and significance of the clinical entity squamositis. Because of the peculiar anatomy and a failure to recognize changes in the roentgen films, disease of the pars squamosa is frequently overlooked.

Disease of the temporal bone, hitherto loosely designated as mastoiditis, has been analyzed and divided into the following three clinical entities: (1) squamomastoiditis (the commonest clinical form), which is disease of the pneumatic cells of both the petromastoid and the squamous bone; (2) mastoiditis, disease of the cells of the petromastoid bone alone; (3) squamositis, disease of the cells of the pars squamosa alone.

An anatomic explanation is given for the clinical phenomenon of sagging of the posterior-superior wall of the external auditory meatus and for a furuncle-like lesion in that region.

A fourth point of tenderness has been described—in the supra-auricular region.

Since the air cell complex of the pars squamosa is largely outside the mastoid process, the complete surgical exposure should be squamo-mastoidectomy rather than the conventional mastoidectomy alone.

Dr. W. F. Whelan permitted me to study the bipartite temporal bone in his collection. Dr. O. V. Batson made many helpful suggestions with respect to the preparation of this paper.

713 Union Street.

Case Reports

EPISTAXIS

Report of a Case of Ligation of the External Carotid and Anterior Ethmoid Arteries

G. S. FITZ-HUGH, M.D.
AND
J. C. RISHER, M.D.
Senior Resident, Department of Otolaryngology, University of Virginia Hospital
CHARLOTTESVILLE, VA.

IN THE past ten years many patients with epistaxis secondary to various conditions have been treated in the department of otolaryngology at the University of Virginia Hospital. The external carotid and anterior ethmoid arteries have been ligated in individual patients, but not until this incident had both been ligated in the same patient to control nasal hemorrhage.

According to Schaeffer,[1] the main intranasal blood supply is from the sphenopalatine artery. The ethmoid and palatine arteries, in addition, contribute to the vascularization of the nose to a lesser degree. From these facts, it is reasonable to assume that in the majority of cases severe epistaxis would be controlled by ligation of the external carotid artery.

The case which we report is that of a patient suffering from severe epistaxis, with hypertension and arteriosclerosis being the causative factors. The external carotid artery was first ligated, after the usual local measures were of no avail, and with no success. Hemorrhage was then completely controlled with the additional ligation of the anterior ethmoid artery.

REPORT OF CASE

W. S. B., a 67 year old white man with hypertension and arteriosclerosis, had suffered no hemorrhage until the night of April 13, 1948. He was awakened by profuse epistaxis, which persisted and required admission to the local hospital. There his nose was packed, and he was given a blood transfusion. The hemorrhage persisted with great severity at intervals, so that on April 16 he was transferred to the University of Virginia Hospital.

On admission the patient exhibited the signs and symptoms of loss of blood; the blood pressure was 110 systolic and 60 diastolic (previously it had been 200 plus systolic and 100 plus diastolic); the red blood cell count was 2,760,000; the hemoglobin content was 7 Gm. per hundred cubic centimeters, and the sensorium was cloudy. The nasopharynx and nasal cavities contained the limit of gauze and cotton packing. There was still slight but steady bleeding into the pharynx. Any effort to remove the packing to examine the nose resulted in massive hemorrhage, accompanied by early signs of shock. Before leaving the admission room, it was necessary to give the patient 3 units (each 500 cc.) of blood.

1. Schaeffer, J. P.: The Nose and Olfactory Organ, P. Blakiston's Son & Co., Philadelphia, 1920, pp. 275-278.

From April 16 to April 19 the hemorrhage persisted in spite of all efforts to control it. At no time could the exact site of bleeding be determined except that the blood was from the left side. Reasoning that such profuse bleeding could have its origin only from the sphenopalatine artery, we ligated the external carotid artery on the afternoon of April 19. Following this procedure, there was still slight bleeding. However, on April 22 all packs were removed. Within twelve hours hemorrhage occurred as before. The anterior and postnasal packs were reinserted. Blood transfusions were again necessary and were given. As the bleeding persisted and the situation remained critical, on Sunday afternoon, April 25, the anterior ethmoid artery was ligated. Following this procedure, active bleeding ceased, and all packs were removed on April 28. Progress thereafter was satisfactory, and the patient was discharged from the hospital on May 6.

At the time of writing, the patient has been under observation as an outpatient for six months, and there has been no epistaxis. The trauma to the mucous membrane of the nose from the packing has subsided. Roentgenologic examinations of the sinuses have shown that previous haziness in the left antrum has cleared.

The patient was given a total of 5,750 cc. of whole citrated blood, vitamin B complex,[2] ascorbic acid and vitamin K in large quantities and calcium intravenously. Oxidized cellulose gauze and plain cotton were used as nasal packs. The coagulation and bleeding times, the prothrombin level, the smears and the differential counts were within the limits of normal.

COMMENT

On many occasions in the procedure for external exenteration of the ethmoid cells we have ligated the anterior ethmoid artery on the orbital side just as it enters the roof of the nasal cavity. We have never been impressed with the size of this vessel or the volume of blood carried by it. In this particular case, the vessel was not unusual, but apparently it must have been the main source of the severe epistaxis.

104 East Market Street (P. O. Box 98).

2. Betalin-Lilly was used, containing 10 mg. thiamine hydrochloride, 4 mg. riboflavin, 150 mg. nicotinamide, 5 mg. pantothenic acid (as calcium pantothenate) and 10 mg. pyridoxine hydrochloride.

Abstracts from Current Literature

Ear

THE PRESENT STATUS OF SURGERY OF THE EAR. L. GARCIA IBANEZ, Rev. españ. de oto-neuro-oftal., (September-October) 1947.

Garcia Ibanez toured various medical centers in the United States and reported his observations on the present day status of surgical treatment for deafness. Following are his conclusions: Otosclerosis is a bony dystrophy of the labyrinthine capsule which when it involves the circumference of the oval window produces a bony ankylosis of the stapes, resulting in a conductive type of deafness. Because of its progressive nature and unknown cause, there has not been any satisfactory medical treatment. Fenestration of the labyrinth with a modern perfected technic is the only treatment which has given positive and permanent results in an increasing percentage of selected cases. The ideal case for the fenestration operation is that of a young person with otosclerosis who has a normal tympanic membrane and clearcut signs of ankylosis of the stapes, whose audiogram shows a loss of air conduction of more than 30 decibels or less than 70 decibels within a conversational range and in whom the bone conduction does not show a greater loss than 30 decibels in the same frequencies. The nasal fossa should be normal and the eustachian tubes patent, and there should be no evidence of infection or allergy. On the other hand, a number of good results have been obtained in cases which deviate from the limits of the so-called ideal one. Permanent results are attained in 60 per cent of the cases if the return of practically normal hearing is considered; if decided improvement in hearing is considered, the results may reach 89 per cent. The vital risk is negligible. Facial paralysis was found to occur once in 150 cases. With the modern technic postoperative closure of the fenestration has been reduced to 5 per cent and traumatic serous labyrinthitis to 1 per cent. This technic has exacting requirements: (1) wide experience with the dry bone and the cadaver; (2) a perfect technic with the proper endaural surgery, the electric drill and operation under magnification; (3) perfect surgical equipment; (4) a perfect surgical team in the operating room. This type of operative procedure is the most difficult of the specialty; yet it is the most revolutionary in the present century.

PERSKY, Philadelphia.

Larynx

A FOREIGN BODY FATALITY. CHARLES C. WOLCOTT, New York State J. Med. **48**:309 (Feb. 1) 1948.

Wolcott warns that to diagnose the presence of a foreign body is not always easy, even by means of roentgenograms. Inflammation and infiltration may becloud the foreign body, so that the shadow remains undiagnosed. A nonopaque object may disclose its presence by producing an obstructive emphysema if it prevents the escape of air on expiration, or an atelectasis if it prevents the by-passage of air on inspiration. "It is imperative that roentgen examination be made at the beginning and end of respiration." If one detects a wheeze, best heard through an open mouth, the presence of a foreign body may be suspected, though it may produce no symptom.

The author presents a case of an 11 month old boy who had swallowed an open safety pin, unknown to any one. On the third day thereafter, emesis developed, followed by refusal of food and a moderate rise in temperature. On the fourth day there were chills, emesis and fever, and the child's condition was mistaken for pneumonia and congenital heart disease. On admission to Grasslands Hospital, the patient was moribund, with a temperature of 103.4 F. Roentgen examination showed a large open safety pin at the lower end of the esophagus, but by the time an esophagoscope was introduced it was no longer there. The following day the child died. Autopsy showed that the pin had lacerated the esophagus in two places and had passed through the mediastinum into the pericardial sac. The pericardial cavity contained 150 cc. of cloudy, gray fluid and many fibrin clots. Cultures of the pericardial fluid and of the blood obtained post mortem showed the presence of Staphylococcus aureus. The author emphasizes the importance of early roentgenographic study in all cases of obstruction of obscure cause.

VOORHEES, New York.

Nose

THE ETIOLOGY, TREATMENT AND PREVENTION OF CHRONIC SINUS INFECTION. S. J. CROWE AND JAMES E. LETT, Ann. Otol., Rhin. & Laryng. **57**:364 (June) 1948.

Pyogenic bacteria are present in the nasopharynx from infancy to old age. Repeated infections with the virus of the common cold facilitate the distribution of bacteria in the nasopharynx and prepare the soil for widespread outbreaks of disease of the respiratory tract. The cold virus enters the nose and is carried to the nasopharynx, where it lodges in the crypts and folds of the lymphoid tissue, penetrates the lining epithelium, breaks down cell membranes and protective barriers and thus provides a portal of entry for the bacteria which are always present in this area. A cellulitis develops; bacteria increase; the resulting edema causes obstruction of the nasal passages or eustachian tubes, and an acute sinusitis or otitis media ensues. When a terminal bronchus is occluded by a similar process, it is reasonable to assume that a condition results there similar to that in the aforementioned structures. In the ear and sinuses it is possible to establish drainage by surgical measures, and in the bronchus, by bronchoscopy and point suction. If these measures are taken to insure drainage in the course of the infection before extensive cellular destruction and granulations have formed, it is possible to prevent chronic infections of the ear and sinuses and it should be possible to prevent chronic suppurative bronchitis. The lymphoid nodules were found in the nasopharynx, in and about the eustachian orifice, near the posterior ends of the middle turbinate bodies and on the posterior and lateral surface of the Vomer. These nodules have crypts, and, though the size of the nodules is not important, the location is. Adequate irradiation will shrink the nodules and flatten and obliterate the crypts so that no favorable places remain in which the virus can lodge long enough for it to enter cells.

The mucosa of the ears and nasal sinuses has a remarkable ability to recover from a single or an occasional infection, but if infections are often repeated they become chronic, necessitating radical operative procedures. The only known way of preventing this is to examine the nasal passages and nasopharynx after an acute infection has subsided, and, if hyperplastic or chronically inflamed lymphoid nodules are found, to use surgical measures or irradiation or both.

The discussion on treatment of acute sinusitis is limited to the frontal sinus. A series of patients admitted to the hospital with acute symptoms were given penicillin intramuscularly and, if pain was severe, were promptly operated on. If pain was less severe, they were given both penicillin and sulfamerazine U. S. P., and heat and vasoconstrictors were used locally. For 16 of 104 patients, the conservative treatment was sufficient; in the others, a ½ inch (1.27 cm.) incision was made through the unshaven eyebrow, just above the inner canthus of the eye, down to the bone. An opening ⅛ inch (3 mm.) in diameter was then made into the sinus with a perforator and a burr; care was taken not to traumatize with retractors or clamps. The contents of the sinus were carefully aspirated after incision of the mucosa, which usually bulges into the wound. Care was taken not to injure further the tissues, and no effort was made to probe the nasofrontal duct. The cavity was filled with penicillin (1,000 units to the cubic centimeter of saline solution) or with tyrothricin suspension (1 cc. of the stock solution in 25 cc. of distilled water). A soft rubber tube was inserted for twenty-four hours, after which the sinus was gently irrigated with warm saline solution once a day. The margins of the wound were painted with phenol to prevent too early closing. The authors have had no cases of complicating osteomyelitis or cellulitis during the several years that they have used this method.

M. V. MILLER, Philadelphia.

STREPTOMYCIN USED LOCALLY IN THE CARE OF CHRONIC SUPPURATIVE MAXILLARY SINUSITIS: REPORT OF A CASE. NATHAN L. FINEBERG, Laryngoscope **58**:545 (June) 1948.

The author discusses a maxillary sinus which had been badly infected for ten months. The culture showed gram-negative bacilli; irrigation with penicillin was not successful, but instillations of streptomycin every twenty-four hours cured the condition in three days. Infection with gram-positive organism followed; this was relieved by instillations of penicillin. Fineberg emphasizes the importance of this therapy and believes that it may often obviate the necessity of a Caldwell-Luc operation.

HITSCHLER, Philadelphia.

NASAL SINUS DRAINAGE: FURTHER BERNOULLI EXPERIMENTS. Z. WILLIAM COLSON, Laryngoscope **58**:642 (July) 1948.

The application of the Bernoulli principle to nasal physiology is a comparatively new and important one. The author presents further reasons to confirm this principle and additional experiments to illustrate it. Colson's previous publications have more information on this subject.

HITSCHLER, Philadelphia.

Miscellaneous

PRIMARY STREPTOCOCCUS VIRIDANS MENINGITIS. STANLEY A. KORNBLUM, CHARLES ZALE and IRVING W. ROBINSON, New York State J. Med. **47**:1387 (June 15) 1947.

A 16 month old white boy entered the pediatric service of Morrisania City Hospital, New York, on February 28, and died on April 6, 1946. Fourteen days before admission the child had a running nose, which cleared spontaneously. Repeated cultures of the blood, urine, stool and material from the throat were all

sterile. No organisms were present in the spinal fluid. Blood chemical studies were all normal. Streptococcus viridans was recovered from the meninges at autopsy. Cultures and smears of the spinal fluid yielded no organisms; the temporal bones revealed no gross evidence of infection. A greenish exudate covered the base of the brain so completely that none of the cranial nerve origins or arteries could be seen without dissection. The exudate extended from the optic chiasm to the medulla and had grown over the roof of the fourth ventricle and the inferior surface of the cerebellar lobes. Both lungs showed terminal bronchopneumonia. The authors, in summary, state that this case was one of primary Streptococcus viridans meningitis which followed an infection of the upper respiratory tract. Details concerning the agents used were not given. Clinically, it resembled tuberculous meningitis because of its chronicity, the failure to isolate any organism, equivocal findings in the spinal fluid and lack of response to chemotherapy.

VOORHEES, New York.

THE PRESENT STATUS OF STREPTOMYCIN. JOHN WINSLOW HIRSHFIELD and CHARLES W. BUGGS, New York State J. Med. **47**:1276 (June 1) 1947.

Working in the laboratories and clinics at Cornell and Wayne universities, at Ithaca, N. Y., and Detroit, respectively, the authors appraise streptomycin, introduced by Schatz, Bugie and Waksman in January 1944. The name was taken from the generic name of the organism that produces it, Streptomyces griseus, a soil actinomycete, which possesses a powerful antibiotic action to gram-negative and gram-positive organisms and is equally effective against Mycobacterium tuberculosis, in vivo and in vitro. Studies of its absorption, distribution and excretion in man after oral and parenteral administration have helped to establish dosage schedules and to prove that it is relatively nontoxic. However, bacteria have been able to develop resistance to streptomycin very rapidly when exposed to sublethal concentrations; therefore, large initial doses must be employed. The toxic effects of this drug are manifest in undesirable reactions of the skin and of the eighth cranial nerve.

Streptomycin has proved to be strikingly effective in the treatment of tularemia, many bacteremias due to gram-negative bacilli, infections of the urinary tract due to susceptible organisms, infections with Friedländer's bacillus and infections caused by Hemophilus influenzae. Its place in the treatment of brucellosis, tuberculosis (including the miliary type) and infections such as peritonitis and suppurative pulmonary disease has not been determined. The authors cite seventy-nine references to articles already published.

VOORHEES, New York.

ROLE OF THEPHORIN PHENINAMINE TARTRATE IN ALLERGIC DISORDERS. H. HAROLD GELFLAND, New York State J. Med. **48**:1947 (Sept. 1) 1948.

Gelfland states that some allergists still do not fully accept the histamine theory of allergy. However, antihistamine drugs have given relief clinically. Tripelennamine hydrochloride (pyribenzamine®) and diphenhydramine (benadryl®) cause many side reactions, but pheninamine tartrate (thephorin®) has fairly good tolerance. The patient, instead of being drowsy, is wakeful at night, but this can be overcome by sedatives or soporifics. An unselected group of 129 patients having various allergies was taken for a test of pheninamine tartrate. The daily dosage was 50 to 100 mg., usually 75 mg. Children received 5 to 40 mg. The drug can be administered for several months without changes in the characteristics of the blood. Of 22 cases of bronchial asthma, improvement

was seen in 59 per cent; and of 64 cases of seasonal hay fever, benefit was recorded in 45.3 per cent. Perennial rhinitis was partially relieved, but no relief was obtained in 5 cases of angioneurotic edema.

The author concludes that pheninamine tartrate has definite histamine-antagonizing qualities—it is an advujant to other antiallergic therapy, does not cause drowsiness during the day and can be continued for months if necessary. The effect lasts three hours, not longer. Temporary relief is all that can be had from any of these "newer remedies."

VOORHEES, New York.

TUBERCULOUS MENINGITIS COMPLICATED BY PREGNANCY. E. G. SILVERMAN and T. M. FEINBLATT, New York State J. Med. **48**:2280 (Oct. 15) 1948.

The authors report that a search of the literature revealed no case of tuberculous meningitis treated by streptomycin with delivery of a healthy baby and subsequent recovery of the mother. Sixty-five cases were reviewed, 36 of men and 29 of women. The ages averaged a little over 26 and ranged from 14 months to 67 years. In 36 cases the spinal fluid revealed Bacillus tuberculosis; in 30 cases diagnosis was not immediately confirmed, but in 10 of these it was verified at autopsy. In the remaining 20, the clinical diagnosis was presumptive. Six patients were treated with streptomycin. The patient reported on in the article is the only survivor. The average period of survival was 66.8 days.

The otologist will be interested chiefly in the otologic examination. Both auditory canals and ear drums were normal, with no tenderness in the mastoid bone. In the Weber test hearing was lateralized to the left. The Rinne test disclosed that air conduction was greater than bone conduction in both ears. The Schwabach test showed that bone conduction was diminished about one half bilaterally. The vestibular function showed no spontaneous nystagmus. The caloric test with ice water, 40 cc. in fifteen seconds, caused no response in either ear. "The impression was of impaired hearing and vestibular function, central type, caused by basilar meningitis and streptomycin reaction." The streptomycin levels ranged from a high of 31 to a low of 1 unit per cubic centimeter; the blood level ranged from a high of 16 to a low of 4 units per cubic centimeter. On Aug. 20, 1948, eight months after leaving the hospital, the patient and baby were alive and well. A total of 315 Gm. of streptomycin was administered intramuscularly over one hundred and five days; a total of 15.4 Gm. was given intrathecally over seventy-two days.

VOORHEES, New York.

SPHENOPALATINE GANGLION BLOCK FOR THE RELIEF OF PAINFUL VASCULAR AND MUSCULAR SPASM WITH SPECIAL REFERENCE TO LUMBOSACRAL PAIN. J. LEWIS AMSTER, New York State J. Med. **48**:2475 (Nov. 15) 1948.

Amster read this essay before the annual meeting of the Medical Society of the State of New York, on May 19, 1948. He says that when one speaks of the autonomic nervous system one often overlooks the four sympathetic cephalic ganglions, namely, the sphenopalatine, ciliary, otic and submaxillary. Sluder was probably the first to call attention to the therapeutic value of anesthetizing the sphenopalatine ganglion for the relief of intractable pain; he reported "cures" so remarkable that many were incredulous. Ruskin, Neuberger and others revived the procedure. Amster reports 103 cases, with relief of pain in 90 per cent, some of them after only one "block." In the chronic cases with

sacroiliac distress, for example, several sittings were required. In about 10 per cent there was no relief, probably because of deep-seated organic trouble with irreversible pathologic changes.

Four figures are used to illustrate the anatomy and the method of application of tetracaine, monocaine, or a similar anesthetic. Amster no longer uses cocaine. A table of "conditions treated" covers such items as migrane, persistent hiccup, intercostal neuritis, dysmenorrhea and ureteral colic. It was brought out in the discussion that the sympathetic nervous system is little understood from a medical standpoint, although the anatomy seems well described in such texts as the twenty-fifth edition of Gray's "Anatomy." The functional relation to diseases in the broad sense is still in the guessing stage. Here is a field for action where a young enthusiast may immortalize his name.

VOORHEES, New York.

A GUIDE TO THE USE OF PROCAINE PENICILLIN IN HOSPITAL PRACTICE. GENE H. STOLLERMAN, EDWARD H. ROSTON and BEATRICE TOHARSKY, New York State J. Med. **48**:2501 (Nov. 15) 1948.

Working at the Mount Sinai Hospital (New York), the authors have drawn interesting comparisons between penicillin G and the procaine salt of penicillin. The former has been useful when given orally in pediatric practice, but its fate in the gastrointestinal tract is uncertain. About five times as much is required when the drug is given orally as when administered parenterally. Penicillin in oil and white wax U. S. P. (Romansky formula), given in doses of 300,000 units intramuscularly, holds a blood level for twelve hours. The advantages are obvious. Procaine penicillin G in oil gelled with aluminum monostearate may hold the blood level for ninety-six hours, or longer! It is assumed that the drug particles become water repellent. These suspensions in oil are stable and do not require refrigeration. But the syringe and needles must be made fat free after use by cleansing with detergents or fat solvents. Certain principles are to be observed: 1. The germs must be penicillin sensitive. If not, 600,000 units must be given daily (twice the ordinary dose). If aluminum monostearate is used as a detergent to elimination, spacing may be one day, or even several days, apart, the interval depending on factors present in a given case. 2. Daily determinations of the blood level are no longer imperative, but identification of the bacterium and its sensitivity to whatever agent is employed is highly important. One must know the enemy! 3. The stock bottle must be shaken thoroughly. A 20 gage needle is inserted into the bottle; fluid is withdrawn, and the site is chosen. The needle is inserted into the muscle (buttocks), care being taken to avoid blood vessels (embolism) and to get deep below the fat. The plunger must be pressed promptly, or the needle will clog. (Cleansing of the hypodermic outfit after use has already been mentioned.) 4. Therapeutic response must be the chief guide to further administration, size of dose and interval of injections. 5. Single dose therapy has been tried, but relapses have been noted. 6. Syphilis and gonorrhea yield to the procaine penicillin, but treatment of the former is still *sub judice* with respect to dosage and length of treatment required. Ten days has been regarded sufficient for syphilis, 300,000 units being administered daily or on alternate days, as seems necessary. As for gonorrhea, "a single injection of 300,000 units of procaine penicillin with or without aluminum monostearate should be adequate for the cure of gonorrhea"! 7. Subacute bacterial endocarditis can be treated with 600,000 units given once a day for

six to eight weeks, but the duration of treatment cannot be shortened by increasing the dose. Streptococcus viridans, when found, may prove resistant over a period of weeks. 8. Prophylaxis before, during or after surgical procedures calls for administration of 300,000 units daily, according to conditions. (Tonsillectomies and dental extractions are mentioned.) 9. Crystalline penicillin G now has relatively few indications as against procaine penicillin. The latter seems to have no cumulative or disturbing effects; the only possible toxicity might come from too much procaine being released. Moreover, procaine may limit the action of the sulfonamide compounds; therefore, crystalline penicillin is to be preferred when one proposes to use the sulfonamide drugs synchronously. Crystalline penicillin is required for topical applications. It is also the agent to be combined with aerosol preparations for use in the antrum or the buccal cavity.

The article is an excellent one and deserves wide reading.

VOORHEES, New York.

HYDROLYZED ORAL HAY FEVER ANTIGENS. HENRY M. FEINBLATT and EDGAR A. FERGUSON JR., New York State J. Med. **48**:2720 (Dec. 15) 1948.

Oral treatment of hay fever with pollen extracts dates from 1922. Hitherto, gastrointestinal reactions have made it unfavorable, but with a process of pollen hydrolysis, this objection disappears. The authors give the formula for mixing these hydrolyzed pollens found effective in most cases. Tablets were made containing 10 mg. each, plus ordinary excipients; one 10 mg. such tablet may be taken as a test dose. If no untoward symptoms develop, the dose may be increased daily by 1 tablet until a maximum of 10 per day are taken. The usual dose is 2 tablets three times a day. The authors discuss the chemistry of allergens and include a table showing examples of hydrolysis. The purpose of the clinical series was to determine the therapeutic effectiveness of tablets of hydrolyzed mixed ragweed and common pollen and the incidence of gastrointestinal irritation and untoward reactions of an allergic nature caused by this medication. The groups consisted of unselected subjects ranging in age from 7 to 59. The chronicity of allergic rhinitis was evident in the average duration of the complaint, which was nine and three-tenths years. In summary, the index of benefit was 78 per cent for oral antigen therapy, but only 44 per cent for injectable antigen therapy. The percentage decrease in days lost from work was 78 per cent with oral antigen therapy and 25 per cent with the injectable antigen. No instance of gastrointestinal irritation was found with oral administration of antigen. These percentages were based on a series of 35 subjects observed over an average of five years.

VOORHEES, New York.

Book Reviews

Plastic Surgery of the Nose. By Albert P. Seltzer, M.D., M.Sc. (Med.), Sc.D.; Associate in Otolaryngology, Graduate School of Medicine, University of Pennsylvania. Price, $12. Pp. 305, with 221 illustrations, including 7 plates in color. Philadelphia: J. B. Lippincott Company, 1949.

The history of plastic surgery is well set forth in the first chapters of this volume, and the antiquity of this field is revealed in the discussion of the amazing work of the ancients, who labored without any "tools of the trade," of which anesthetics may especially be noted. In general, the principles of this art have been well set since the turn of the twentieth century, and they do not vary notably. Every operator has certain favorite methods, but these are subordinate to well established technics. The most illuminating chapter in this book is the nineteenth, which deals with "The Unsuccessful Operation—Its Causes and Prevention." Common surgical errors result from the doing of too much or too little, a failing of essentially all human beings, and not of surgeons alone. The author allows for this, and concludes that ". . . the most important factors for success are observation and experience."

Phylogenesis of the Ear. By Louis Guggenheim, M.D. Price, $12.50. Pp. 266. Hollywood, Calif.: Murray & Gee, Inc., 1949.

This book is an erudite and academic classic. It gives tremendous detail on the history and growth of the structure of the ear throughout the animal scale. Going back three or four hundred million years to examine the hearing apparatus in fossil layers, as the author does, is starting a priori, to be sure. The many beautiful illustrations, with their carefully written captions, make this book a veritable storehouse for anyone interested in comparative anatomy. It was interesting to learn that the cochlea of the cat and dog has three turns and that these animals hear much better than man, but why should the cochlea in the lowly pig have four turns?

This volume is indeed worth while reading for all otolaryngologists, and should be compulsory reading for the graduate student in this specialty.

Directory of Otolaryngologic Societies *

INTERNATIONAL

Fourth International Congress of Otolaryngology

President: Dr. V. E. Negus, London, England.
General Secretaries: Dr. F. C. W. Capps and Dr. W. A. Mill, 45 Lincoln's Inn Fields, London, W. C. 2.
Place: London. Time: July 18-23, 1949.

Second Pan-American Congress of Oto-Rhino-Laryngology and Bronchoesophagology

President: Prof. Justo Alonso.
Secretary: Dr. Chevalier L. Jackson, 255 S. 17th St., Philadelphia 3.
Place: Montevideo. Time: January 1950.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Henry B. Orton, 224 Delavan Ave., Newark, N. J.
Secretary: Dr. J. Milton Robb, 1553 Woodward Ave., Detroit, Mich.
Place: Atlantic City, N. J. Time: June 6-10, 1949.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Conrad Berens, 35 E. 70th St., New York.
President-Elect: Dr. J. Mackenzie Brown, 1136 W. 6th St., Los Angeles 14.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave. Bldg., Rochester, Minn.

American Broncho-Esophagological Association

President: Dr. Paul Holinger, 700 N. Michigan Ave., Chicago 11.
Secretary: Dr. Edwin N. Broyles, 1100 N. Charles St., Baltimore.

American Laryngological Association

President: Dr. Frederick T. Hill, 177 Main St., Waterville, Maine.
Secretary: Dr. Louis H. Clerf, 1530 Locust St., Philadelphia 2.
Place: Biltmore Hotel, New York. Time: May 16-17, 1949.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. John J. Shea, 1018 Madison Ave., Memphis, Tenn.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester 7, N. Y.

SECTIONS:

Eastern.—Chairman: Dr. Harold G. Tobey, 403 Commonwealth Ave., Boston.
Southern.—Chairman: Dr. Watt W. Eagle, Duke University, Durham, N. C.
Middle.—Chairman: Dr. Dean M. Lierle, University Hospital, Iowa City.
Western.—Chairman: Dr. Leland G. Hunnicutt, 98 N. Madison Ave., Pasadena, Calif.

American Otological Society

President: Dr. Marvin F. Jones, 121 E. 60th St., New York.
Secretary: Dr. Gordon D. Hoople, Medical Arts Bldg., Syracuse 3, N. Y.
Place: Biltmore Hotel, New York. Time: May 18-19, 1949.

American Otorhinologic Society for the Advancement of Plastic and Reconstructive Surgery, Inc.

President: Dr. Samuel F. Kelley, 47 E. 61st St., New York 21.
Secretary: Dr. Norman N. Smith, 291 Whitney Ave., New Haven 11, Conn.

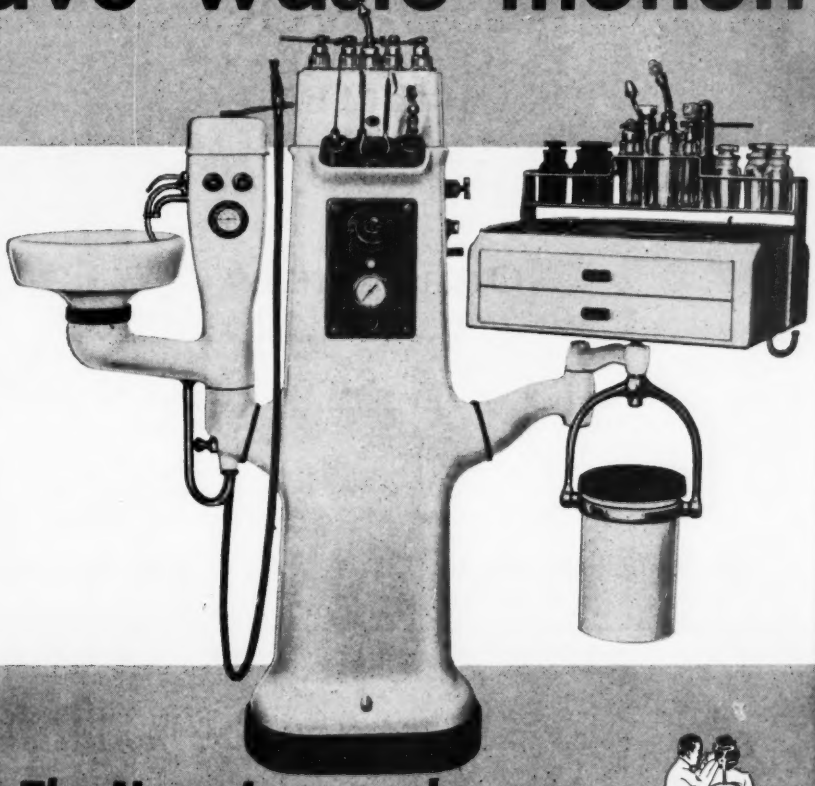
American Society of Ophthalmologic and Otolaryngologic Allergy

President: Dr. Rea E. Ashley, 384 Post St., San Francisco.
Secretary-Treasurer: Dr. Joseph Hampsey, 806 May Bldg., Pittsburgh 22.

---

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

save waste motion

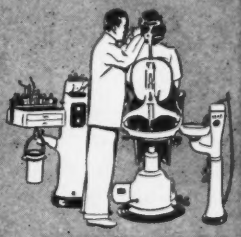


with The New, Improved Ritter ENT Unit

Here in one centralized installation, immediately at your finger tips, are all the low voltage instruments, air, water, vacuum and waste facilities you need for complete examination and treatment right in your own office.

New, Completely Redesigned Cuspidor—provides greater efficiency at low water pressures, with four times as much vacuum by volume. Finger-tip regulation at aspirator handle.

No moving from your operating position, whether standing or seated. Pick up any instrument—the current goes on. Return instrument—current cuts off. Save time, save wasted motion . . . enjoy the convenience of a modern Ritter ENT Unit. Call your surgical dealer for a full demonstration of Ritter's many exclusive features. Or write us for literature.



Ritter Units are designed in four models—positioned either side of the chair, and with or without swinging cuspidor. There's a model to fit your operating technique.

Ritter
COMPANY INCORPORATED
RITTER PARK, ROCHESTER 3, N. Y.

If vacationing in New York State, visit our plant and see quality Ritter equipment manufactured.

ISO-PAR
(Coparaffinate)
OINTMENT

Contains 17% Iso-Par (14 parts Iso-Paraffinic Acids, C_8-C_{18}, Av. Mol. Wt. 174, modified by 3 parts Mixed Amine Salts, principally 2-Hydroxy-5-Iso-Octyl-N, N-Dimethyl Benzylamine Salts of Iso-Paraffinic Acids, i. e., Iso-Octyl-Hydroxy-Benzyl-Dimethyl-Ammonium-Iso-Paraffinate), Cetyl Alcohol, Beeswax, Titanium Dioxide, Lanolin, Petrolatum, Essential Oils.

indicated in

OTITIS EXTERNA

Specific in Otomycosis. Highly effective in multiple infections. The advantages of symptomatic relief and absence of irritation throughout treatments are notable, also.

FUNGICIDAL
BACTERICIDAL

ANTIPRURITIC
STIMULATING

WALKER, J. S., BULLETIN OF THE JOHNS HOPKINS HOSPITAL, SEPTEMBER 1948: 225-228
REARDON, W. T., ARCHIVES OF OTOLARYNGOLOGY, MARCH 1947: 294-297

Available at pharmacies. Supplied in 1 lb., ¼ lb., 1 oz. and ½ oz. jars. Samples upon request

Medical Chemicals, Inc., 406 E. Water St., Baltimore 2, Md.

Storz
Surgical Instruments

Molt Storz Tonsillectome

Again in Production
The Molt Storz Tonsillectome with the "loop in fenestra"

Complete total enucleation with a dull blade, no tearing or stripping

Thumb lever provides powerful leverage. One hand only is needed to operate blade either forward or backward

Medium size now available
Small and Large sizes shortly

All Stainless Steel Construction
$75.00

Storz Instrument Company 4570 Audubon Ave. St. Louis, Mo.

If you want a TREAT instead of a TREATMENT... smoke Old Golds

We get along fine with doctors, bless 'em. They stick to their business; we stick to ours —and *you* get a break both ways! Old Gold cures just one thing, the world's best tobacco. All of our nearly 200 years' tobacco know-how goes into the making of the world's most enjoyable cigarette—smooth, flavor-rich, mellow-mild Old Gold! Today, light an Old Gold and see if we don't deliver *plenty* of the one thing we promise: an honest-to-goodness smoking *treat*.

A safe, simple Mouth Gag for Tonsillectomy

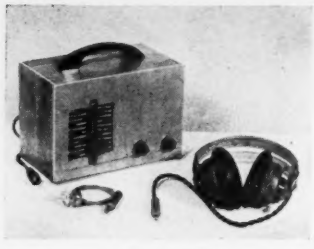
Hazards of trauma pressure on the incisors by the usual mouth gag are eliminated by this simple instrument

CONTACT is placed behind the canine teeth. The instrument provides better exposure and fits any mouth...from small child to adult. Easily adjusted from side to side, always with two-point contact. Three sizes of tongue blades are provided. The contact portion of the ring is covered with small rubber tubing, as an added protection. This gag may be used on edentulous patients.

The new Atraumatic Mouth Gag, of fine material and workmanship, with three sizes of tongue blades . . . . COMPLETE **$25.00**

Consult your Dealer or write to...

ATRAUMATIC MOUTH GAG CO. 418-30th Street · OAKLAND 9, CALIFORNIA



Precision Table Aid ($40 to $65)

DOUBLY DESIRABLE

- for relieving the strain of office interviews with the hard of hearing.
- for educating the hearing of child or adult with well amplified sound . . . paving the way for the use of a wearable hearing aid.

PRECISION HEARING AIDS
850 W. Oakdale Ave. : : Chicago 14

NATIONAL HEARING WEEK MAY 8-14

TWO NEW SERVICES for YOUR DEAFENED PATIENT

HEARING AID CONSULTATION

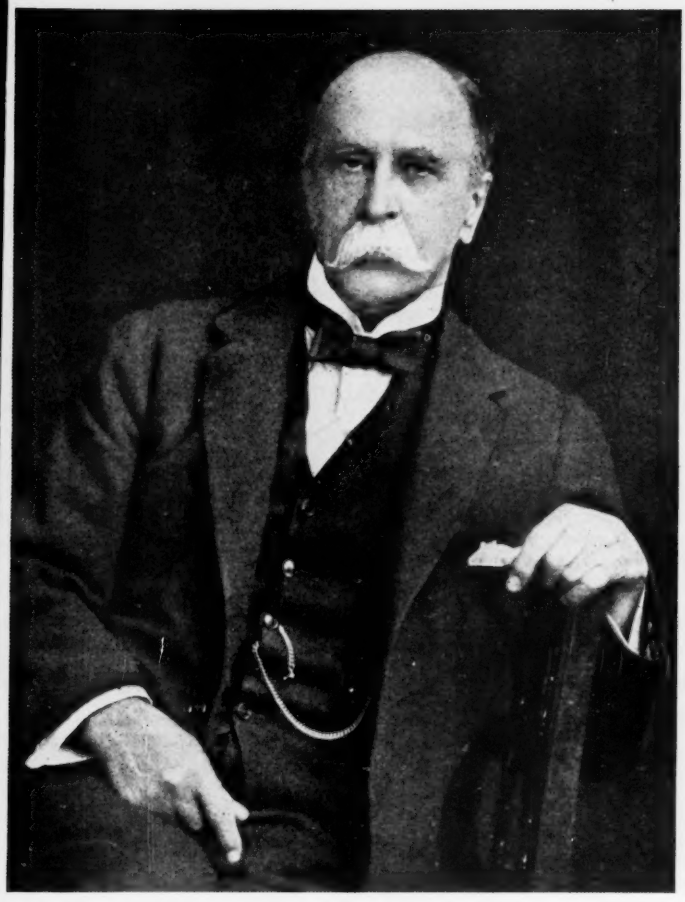
To help in the selection of the aid best suited to each person's needs.
We do not sell Hearing Aids. Only Council-accepted aids demonstrated.

AUDITORY TRAINING

To help the user get maximum benefit from his hearing aid.
To help train his hearing and to teach him to combine lip reading and hearing.

Information on request.

THE NITCHIE SCHOOL OF LIP READING, INC.
Founded 1903
342 Madison Ave. New York 17, N. Y.
Murray Hill 2 — 6423
Chartered by New York State Board of Regents



WILLIAM OSLER
Pioneer in American Medicine
Born 1849—Died 1919

The July number of ARCHIVES OF INTERNAL MEDICINE is the William Osler Centenary issue. Here is an inspiring story of medical progress told in intimate glimpses by his friends and students.

Additional copies of this, the William Osler Centenary issue of the ARCHIVES OF INTERNAL MEDICINE, are available . . . or send in the coupon below for your subscription to ARCHIVES OF INTERNAL MEDICINE beginning with the current number.

The Osler Memorial issue is "must" reading for every physician and an inspiration to all students of medicine.

American Medical Association
535 North Dearborn Street
Chicago 10, Illinois

Please send me:

.....copies of Osler Memorial issue of ARCHIVES OF INTERNAL MEDICINE at $0.75 each.

.....year subscription to ARCHIVES OF INTERNAL MEDICINE at $8.00 per year.

Name .....

Street .....

City ..... Zone..... State.....

SMR Ear Speculum. Black, non-reflecting, light in weight, warm the touch, non-metallic, no plating to chip off, can be sterilized.

Price.....$2.50 per dozen. Add $2.00 for Ra

Malleable Cannulas. These are furnished in two sizes and can bent into any shape for entering ear or nose. The proximal end is tapered that it can be attached to your cut-off for drying out the ear.

Price .....$1.

Light Shield. The apparatus consists of a polished bakelite shield enclose an ordinary 100 watt lamp. This shield can be attached to any standa socket and can be rotated independently of the lamp and the opening can turned in any direction. The shield avoids danger from bursting bulbs a serious burns.

Price—No. 2 Light Shield.....$5.00. Add $3.50 for condens

Respiratory Protector is designed to cover the mouth and face. It light in weight and can be instantly rotated out of the way for telephoning conversation. While it can be attached to any headband having a projectir stud, it functions better on the above headbands. New transparent portion ca be quickly replaced when soiled or worn.

Price—Respiratory Protector SJ3.....$2.

SMR

Surgical Mechanical Research

1901-1903 Beverly Blvd. **Los Angeles, Cali**

'XTRA THIN

ONE-CASE • ONE-CORD
LIGHT WEIGHT

PARAVOX HEARING AID

Brings to the ear, clearly, increased volume of sounds. Slender. Light. Only one case, one cord and receiver.

60 HOURS — 10c

Through the use of the 'A'conomizer, an 'A' battery costing 10c and lasting at least 60 hours, can be used, when desirable.

ONE - MINUTE SERVICE

No waiting for repairs. Quick service at any Paravox dealer anywhere.

Accepted by Council on Physical Medicine, American Medical Association

'A'conomizer cuts costs

PARAVOX, INC.

2056 EAST 4th STREET • CLEVELAND 15, OHIO

DOCTOR:

Don't give your patient an ordinary eye patch. Prescribe the

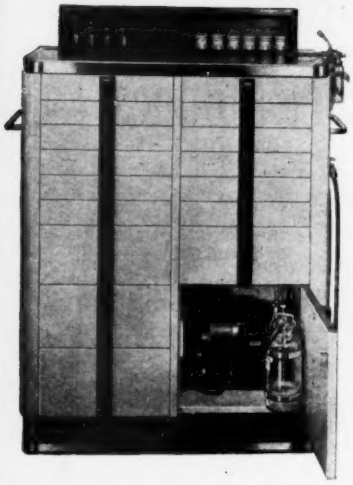
*"ADJUSTO"
Eye Shield

AMBLYOPIA EXANOPSIA — Will not interfere with lid movement.
CORNEAL ULCER—Will admit air through shield.
INJURED OR POST-OPERATIVE CONDITION—Will do away with any unnecessary pressure.

The "ADJUSTO" is the only shield with a flexible frame that conforms to the facial contours, and expanding pleats adjustable to the eye dressing, without applying pressure. It is the only eye shield made which can be moulded around the lens of eye glasses with simple ease. The "ADJUSTO" can be boiled or autoclaved for sterilizing, or can be washed with soap and water and the pleats will not come out! Available at all leading Drug, Surgical and Optical stores. Retails at 50c.

ADJUSTO EYE SHIELD COMPANY
1060 Lexington Avenue, New York 21, New York

A Complete Treatment Unit



YOUR PRESENT TREATMENT CABINET can also be made into an efficient complete treatment unit by the installation of a dependable Mueller Suction-Pressure or Ether-Suction-Pressure Unit. It is inexpensive, too. Write, stating type of cabinet and current you have, for details.

MAKES THE MOST OF YOUR BUSIEST HOURS

And this new Mueller-Hamilton Treatment Cabinet for eye, ear, nose and throat work has just about everything to make the most of your productive time. It rolls up to the treatment chair so that you can do more of your work comfortably seated—off your feet. Its large working surface, unbreakable, is at just the right height—40" from the floor—has a raised rim to prevent things from rolling off. A handy medicine bottle rack disappears into this top, raised by the mere touch of a button. 14 steel-wood drawers accommodate practically every item you need in your daily practice, conveniently arranged.

Built-in is a compact, powerful Mueller Suction-Pressure Unit. It is dependable and quiet. It is also completely hidden from the patient. You have spray pressure and vacuum ready at the flip of a switch.

This EENT Unit is surprisingly reasonable. Write, stating electric current, for full details . . . Today!

Everything for Surgery—Since 1895

V. Mueller and Company

408 S. HONORE STREET CHICAGO 12, ILLINOIS

Sinus Infections

rarely remain localized and if untreated often cause serious tissue destruction. Nasopharyngeal antisepsis as acomplished with the

Nichols NASAL SYPHON

has become routine practice in many clinics oftentimes obviating the necessity of surgical intervention. It quickly allays SINUS PAIN due to congestion as it removes the cause-plugs of inspissated mucopus in the sinus openings—thus reestablishing necessary DRAINAGE and VENTILATION. Send in coupon for detailed information.

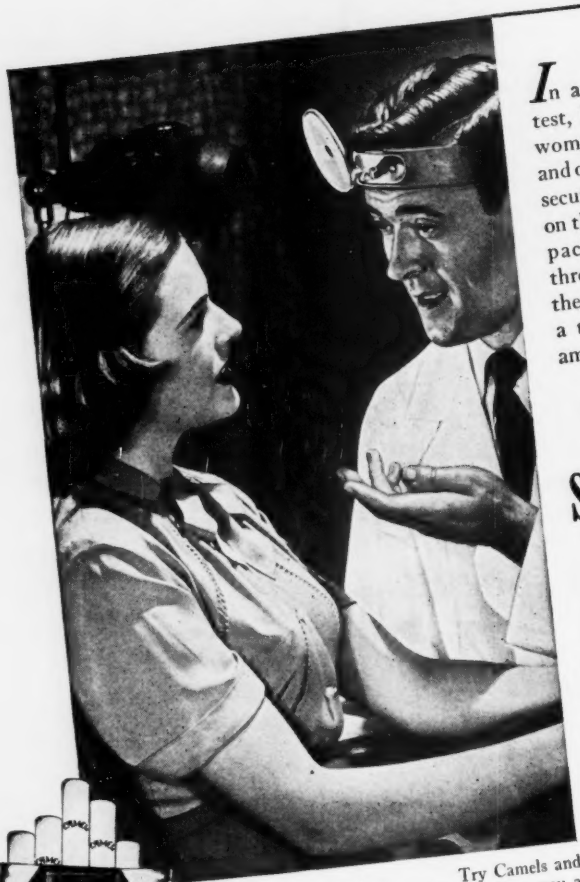
NICHOLS NASAL SIPHON, INC. MONTCLAIR, N. J.

Send details of your SPECIAL OFFER "S" without obligation.

_____ M.D. City _____ Zone No. ___

Address _____ State _____

Here's what throat specialists reported about Camel Mildness—



In a recent coast-to-coast test, hundreds of men and women smoked Camels—and only Camels—for 30 consecutive days. They smoked on the average of one to two packs a day. Each week throat specialists examined the throats of these smokers, a total of 2470 careful examinations, and reported

"NOT ONE SINGLE CASE OF THROAT IRRITATION due to smoking CAMELS"

Money-Back Guarantee!

Try Camels and test them as you smoke them. If, at any time, you are not convinced that Camels are the mildest cigarette you've ever smoked, return the package with the unused Camels and we will refund its full purchase price, plus postage. (*Signed*) R. J. Reynolds Tobacco Company, Winston-Salem, North Carolina.

According to a Nationwide survey:

MORE DOCTORS SMOKE CAMELS

than any other cigarette

Doctors smoke for pleasure, too! And when three leading independent research organizations asked 113,597 doctors what cigarette they smoked, the brand named most was Camel!

THE ARCHIVES OF OTOLARYNGOLOGY is published by the American Medical Association to stimulate research in the field of otology and laryngology and to disseminate knowledge in this department of medicine.

Manuscripts for publication, books for review and correspondence relating to the editorial management should be sent to Dr. George M. Coates, Chief Editor, 1721 Pine Street, Philadelphia 3, or to any other member of the Editorial Board. Communications regarding subscriptions, reprints, etc., should be addressed, ARCHIVES OF OTOLARYNGOLOGY, American Medical Association, 535 North Dearborn Street, Chicago 10.

Articles are accepted for publication on condition that they are contributed solely to the ARCHIVES OF OTOLARYNGOLOGY. Manuscripts must be type written, preferably double spaced, and the original copy should be submitted. Zinc etchings and halftones will be supplied by the Association when the original illustrations warrant reproduction and when their number is not considered excessive.

Footnotes and bibliographies (the latter are used only in exhaustive reviews of the literature) should conform to the style of the *Quarterly Cumulative Index Medicus*. This requires, in the order given: name of author, title of article and name of periodical, with volume, page, month—day of month if the journal appears weekly—and year.

Matter appearing in the ARCHIVES OF OTOLARYNGOLOGY is covered by copyright, but as a rule no objection will be made to its reproduction in a reputable medical journal if proper credit is given. However, the reproduction for commercial purposes of articles appearing in the ARCHIVES OF OTOLARYNGOLOGY or in any of the other publications issued by the Association will not be permitted.

The ARCHIVES OF OTOLARYNGOLOGY is issued monthly. The annual subscription price (for two volumes) is as follows: domestic, $10.00; Canadian, $10.40; foreign, $11.00, including postage. Single copies are $1.00, postpaid.

Checks, money orders and drafts should be made payable to the American Medical Association.

OTHER PERIODICAL PUBLICATIONS
of the American Medical Association

THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION—Weekly. Covers all the medical sciences and matters of general medical interest. Illustrated. Annual subscription price (three volumes): domestic, $12.00; Canadian, $13.50; foreign, $16.00. Single copies, 35 cents.

ARCHIVES OF INTERNAL MEDICINE—Monthly. Devoted to the publication of advanced original clinical and laboratory investigations in internal medicine. Illustrated. Annual subscription price (two volumes): domestic, $8.00; Canadian, $8.40; foreign, $9.00. Single copies, 85 cents.

ARCHIVES OF NEUROLOGY AND PSYCHIATRY—Monthly. A medium for the presentation of original articles on nervous and mental diseases, with abstracts from foreign and domestic literature, book reviews, transactions of special societies, etc. Illustrated. Annual subscription price (two volumes): domestic, $10.00; Canadian, $10.40; foreign, $11.50. Single copies, $1.00.

ARCHIVES OF DERMATOLOGY AND SYPHILOLOGY—Monthly. Devoted to advancing the knowledge of and progress in cutaneous diseases and syphilis. Publishes original contributions and abstracts of the literature on these two subjects, transactions of the important dermatologic societies, book reviews, etc. Illustrated. Annual subscription price (two volumes): domestic, $10.00; Canadian, $10.40; foreign, $11.00. Single copies, $1.00.

AMERICAN JOURNAL OF DISEASES OF CHILDREN—Monthly. Presents pediatrics as a medical science and as a social problem. Includes carefully prepared reviews, based on recent pediatric literature, abstracts from foreign and domestic literature, book reviews, transactions of special societies, etc. Illustrated. Annual subscription price (two volumes): domestic, $10.00; Canadian, $10.40; foreign, $11.50. Single copies, $1.00.

ARCHIVES OF SURGERY—Monthly. Devoted largely to the investigative and clinical phases of surgery, with monthly reviews on orthopedic and urologic surgery. Well illustrated. Annual subscription price (two volumes): domestic, $10.00; Canadian, $10.40; foreign, $11.00. Single copies, $1.00, except special numbers.

ARCHIVES OF OPHTHALMOLOGY—Monthly. Includes original articles on diseases of the eye, abstracts from foreign and domestic literature, book reviews, transactions of special societies, etc. Illustrated. Annual subscription price (two volumes): domestic, $10.00; Canadian, $10.40; foreign, $11.00. Single copies, $1.00.

ARCHIVES OF PATHOLOGY—Monthly. A periodical devoted to the publication of original articles and general reviews in the field of pathology. Illustrated. Annual subscription price (two volumes): domestic, $6.00; Canadian, $6.40; foreign, $7.00. Single copies, 75 cents, except special issues.

QUARTERLY CUMULATIVE INDEX MEDICUS.—Quarterly. A complete subject and author index to the worth while current medical literature of the world. Issued four times a year. Second and fourth volumes bound for permanent reference. Subscription price, calendar year: domestic, $15.00; Canadian, $17.00; foreign, $17.00.

AMERICAN MEDICAL ASSOCIATION
535 North Dearborn Street **CHICAGO 10**

CONTENTS

PAGE

Functioning of the Air Cell System of the Mastoid Process in Audition. PHILIP G. MACDONALD, M.D., NEW YORK 447

Antral Window in the Middle Meatus: Experiments and Presentation of Cases in Which an Antral Window Was Made in the Middle Meatus of the Human Subject and No Additional Surgical Procedures Were Performed. W. W. WILKERSON JR., M.D., NASHVILLE, TENN. 463

Symptomatic Elongated Styloid Process: Report of Two Cases of Styloid Process–Carotid Artery Syndrome with Operation. WATT W. EAGLE, M.D., DURHAM, N. C. 490

Radiation Therapy for Conductive Deafness: Report of Results and Discussion of Roentgen and Radium Irradiation. HARRY C. ROSENBERGER, M.D., CLEVELAND 504

Hearing Reeducation Without the Use of Hearing Aids: A Report, Analysis and Interpretation of the Results in Fifty Hard of Hearing Persons. VICTOR L. BROWD, M.D., NEW YORK 511

Is It Possible to Cover the Fenestra Nov-Ovalis with Shrapnell's Membrane? An Anatomic Study. SAMUEL ROSEN, M.D., NEW YORK 529

Hemangioma of the Ear and Mastoid Process: Report of Two Cases. M. VALENTINE MILLER, M.D., PHILADELPHIA 535

Clinical and Pathologic Aural Findings in a Case of Carcinomatosis of the Meninges. EUGEN GRABSCHEID, M.D., NEW YORK 547

Squamositis, Mastoiditis and Squamomastoiditis. DOMINICK A. DELISA, M.D., SCHENECTADY, N. Y. 558

CASE REPORTS:

Epistaxis: Report of a Case of Ligation of the External Carotid and Anterior Ethmoid Arteries. G. S. FITZ-HUGH, M.D., AND J. C. RISHER, M.D., CHARLOTTESVILLE, VA. 564

ABSTRACTS FROM CURRENT LITERATURE 566

BOOK REVIEWS 573

DIRECTORY OF OTOLARYNGOLOGIC SOCIETIES 574